Model Mechanics

February 1980 45p
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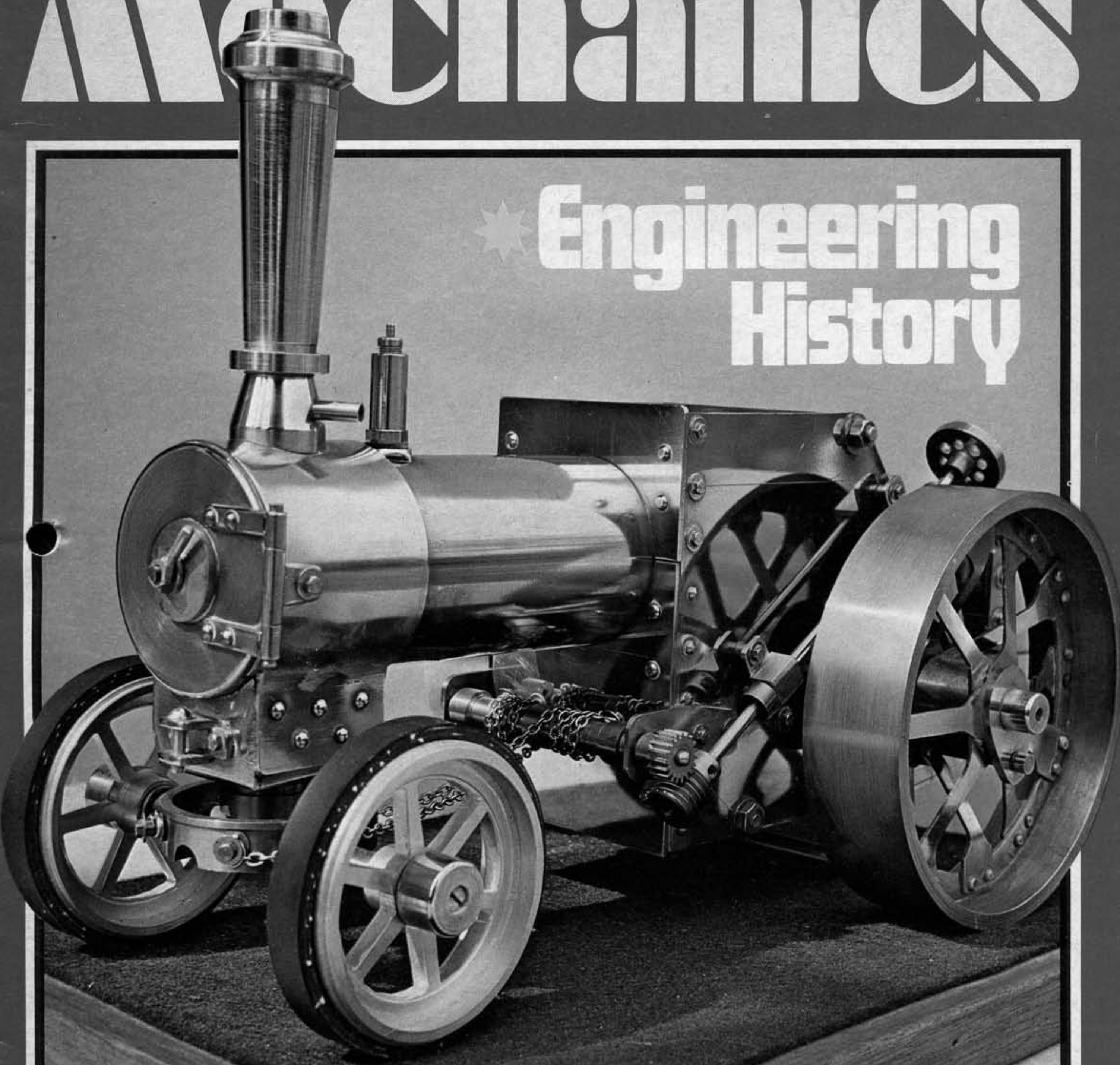

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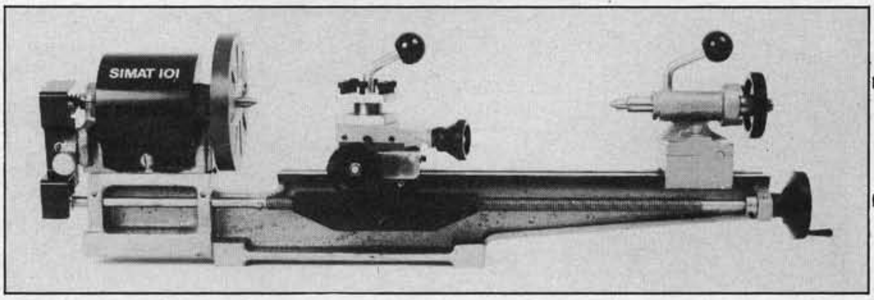

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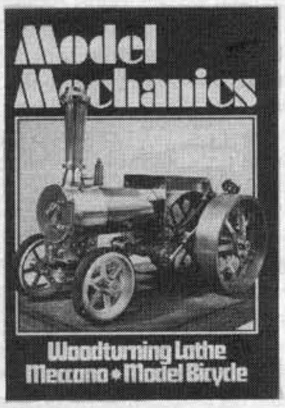

Miniature Traction Engine
by Mr. I. Belcher

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IN THE PAST MONTHS I have had quite a few requests for a boiler to power the oscillating engines we have published in Model Mechanics. Stan Bray, Associate Editor of Model Engineer, has designed one for us (see page 700), this will give a good 8lb psi and is ideal for a boat up to 30in. long. I found Stan's experiments with tin can boilers most interesting, but it must be pointed out however that playing around with any pressurising system can havev its dangers, so what ever type of boiler you make, test it with care. The best way is to give a hydraulic pressure test. This is achieved by filling the boiler full of water, making sure there are no pockets of air left inside the boiler. Then fit a pressure gauge at the top of the boiler and a water pump with a non-return valve as low as possible. A bicycle pump and a Schraeder valve would suffice, if you fit the valve to the boiler, fill the pump with water excluding all air before screwing on to the valve. One more point about safety, with a small boiler a hand pump can be fitted to keep the boiler topped up with water while working. The danger here is if the boiler runs dry and water is injected into it, the pressure can rise very qucikly above the safety level.

Still on the subject of steam and boilers, Rex Tingey has supplied detals of his water pump and a blower that he has designed for his Sweet 16 traction engine that we published in Model Mechanics (July to November 1979).

A pump of this design apart from being used for the hydraulic test, can also be installed with the plant to top up the boiler as required.

Next month I will be able to satisfy another request I have had for information about hardening and tempering; Stan Bray is going to write on this plus the use of metals in the workshop.

Well, that's about all for this month.

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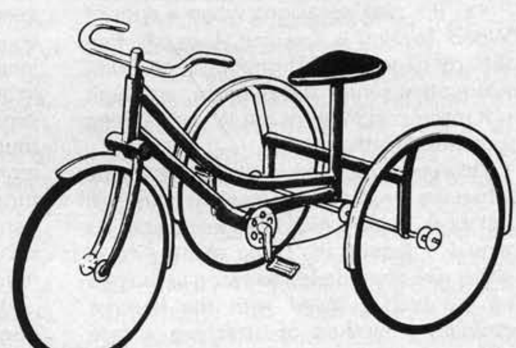

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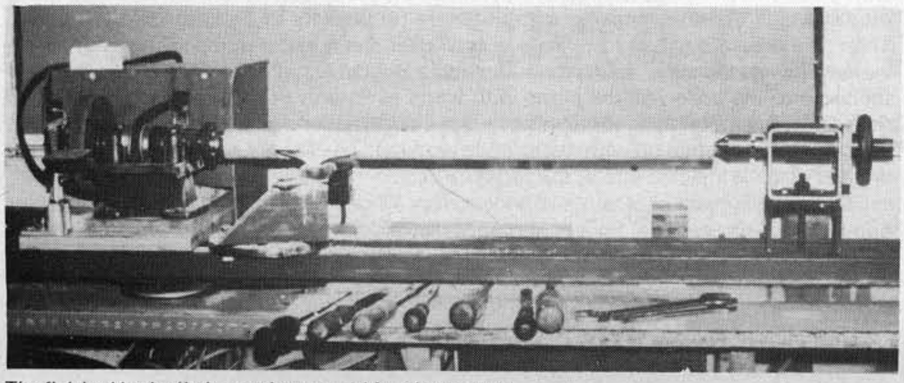
How to make a Woodturning Lathe

by Ken Gibbs



The finished Lathe (belt guards removed for photograph).

On the odd occasions when a spot of Wood Turning is required, I usually find that by 52-year-old Drummond 'M' quite adequately serves the purpose, although not really designed for the Wood Turning Function of lathework.

However, there inevitably comes a time when the 'best laid schemes' etc., just will not work. A job which I had decided to do would not quite fit, being about $\frac{3}{8}$in. in either direction too big to swing in the gap of the bed. I toyed with the idea of devising a method of attaching a face plate to the change wheel end of the mandrel, a position often utilised on lathes designed for wood turning, but I was deterred by the thought of either having to remove all the change wheel gear)with the chore of having to replace it), or having to clear off all the dust and turnings, which seem to get into everything when wood turning, if I left them in place.

I then had the idea that a useful addition to the workshop would be an actual cheap wood-turning lathe, which although it probably would not earn its keep, was always a useful piece of equipment to have and I toddled off to the local machine tool stockist. Once again 'a best laid scheme' went straight out of the window, as (I must be getting old), I found there was no such thing as a cheap anything these days and with the metal-turning lathes at £400 plus and a common garden wood-turning lathe at around £200-£300, it was a case of beating a hasty retreat back to the drawing board.

One thing my fruitless trip did provide, however, was a leaflet or two and a look at the design of modern wood-turning lathes with all the saw and planer attachments etc., which made me wonder what the old craftsmen would have thought when comparing these with the old lathes, quite plain, for just turning. Such fine work was done, and many of these lathes were often made completely of wood! The only metal bits being the mandrel, cast iron bearings and the tailstock point. (I often wonder how many of the owners use the attachments on the modern lathes).

Reflecting on these things and with the pipe drawing well, I decided that a compromise somewhere between the two extremes was a possibility, designed to cost as little as possible. I first thought of devising a simple 'headstock' only for the requirement of the job in hand, a sort of bowl-turning fixture, but the extension of the headstock onto a bed to make a complete lathe soon became the object of the exercise.

I went out to the workshop and started rummaging through my spares, scrap and 'Handies' boxes, it is surprising over the years what one acquires, and I dug out old plummer blocks, pulleys, countershafts etc., spread them on the bench and stood back for a quiet think.

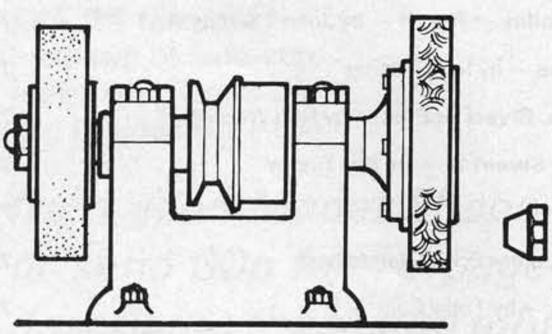
I decided that the total length of the lathe should be 5ft., that it should take up as little space as possible, and on the only available bench, it should also form a base to carry my grindstones and hand-shaper. It was whilst looking at the site for the lathe that I had the best idea of the lot! One item which would have to be accommodated was the grindstone and a close examination gave me a perfect headstock for the wood-turning lathe.

The double head grindstone was of the old-fashioned type (it must be at least 40 years old) originally with flat 'fast and loose' pulleys which I had swopped a long time ago to 'Vee' belt. The polishing mop was screwed to a flange which was itself rutted onto a coned end on the spindle, the grinding wheel secured between plates on the usual threaded and rutted opposite spindle end. The $\frac{7}{8}$in. dia. sp... bronze bearings were in good conditio... and from the flat base of the casting, the spindle end had a centre height of 4 in.

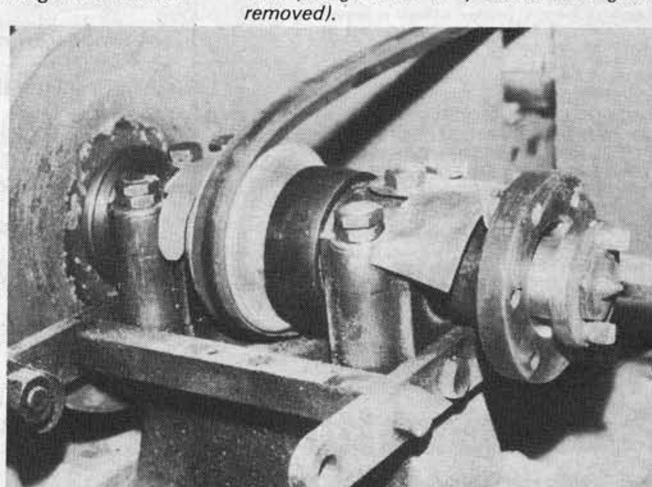
The cast base is a very simple symmetrical shape, being the same front or rear, so by turning the complete assembly end for end, the flanged spindle end adopted the position of a lathe mandrel nose. An easily attachable 'faceplate', from an old working machine pulley forms the basis for attaching larger wooden face plates for the 'bowl turning' function.

The only alteration I made to the

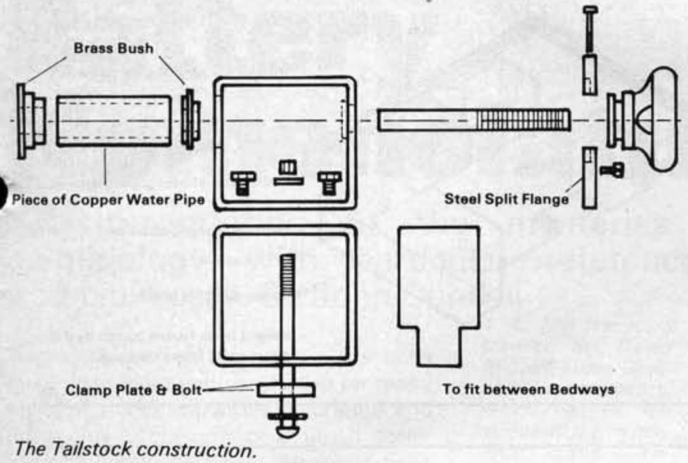
Original Grinder



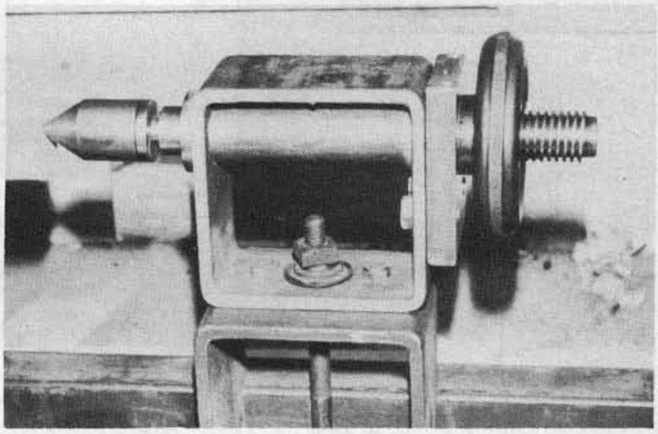
Mop mounted over special coned flange retaining nut



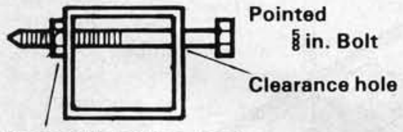
Headstock showing flange for faceplate and with prong centre in position (belt guards removed).



The Tailstock construction.


The completed article.

Although a full Tailstock assembly has been adapted, a simple 'centre' could be made up as follows:



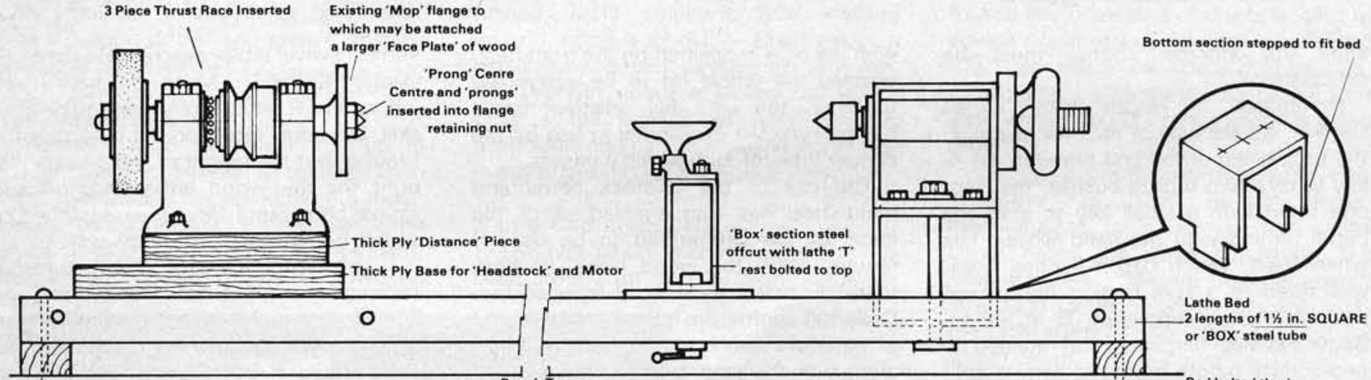
original spindle, was the introduction of a 3-piece thrust race between the 'Vee' pulley and the left-hand bearing face of the casting. This works well in taking any thrusts imposed by the cutter or tailstock centre. On its bed, of course, the whole thing is retained as a grindstone until removal of the cup wheel or mop, and the attachment of the plate or prong centre converts the grindstone into a lathe.

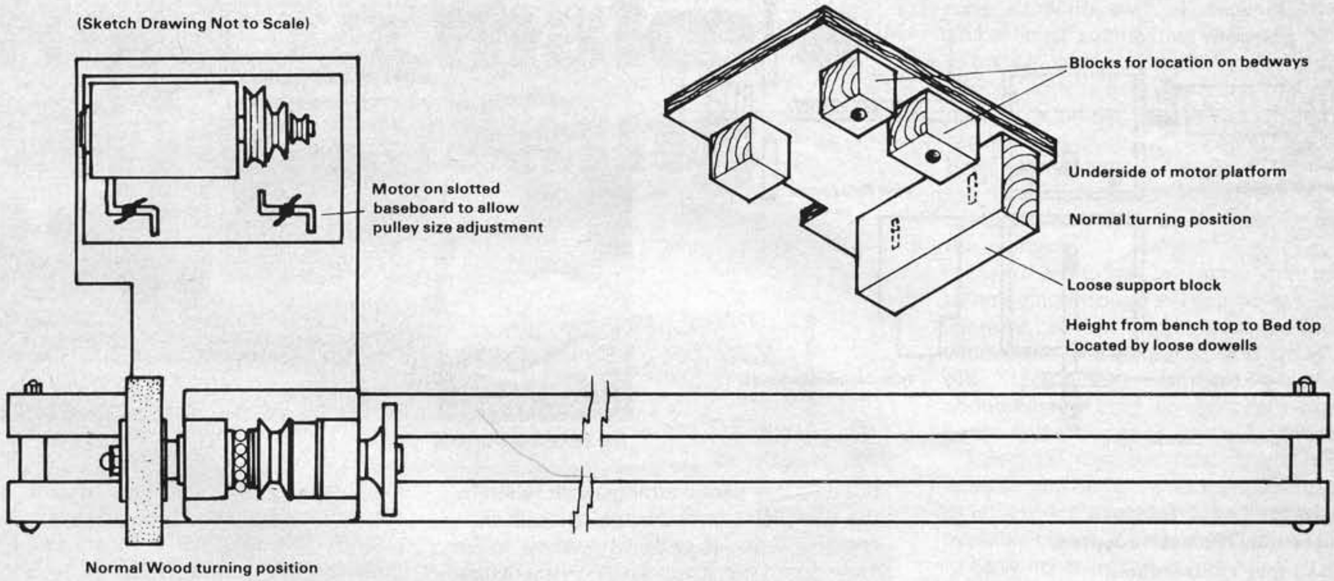
By the use of spacer blocks, the centre height is taken to 6 in. (you could use any thickness blocks for any height required), but a further useful arrangement whereby the complete head swings through 90°, enables large lid or bowl turning to be done from the front of the lathe where one normally stands, and not around at the end is conventional, meaning either an awkward twist over a bench or a completely free and unobstructed lathe end, not always possible in the small workshop, and certainly not in mine.

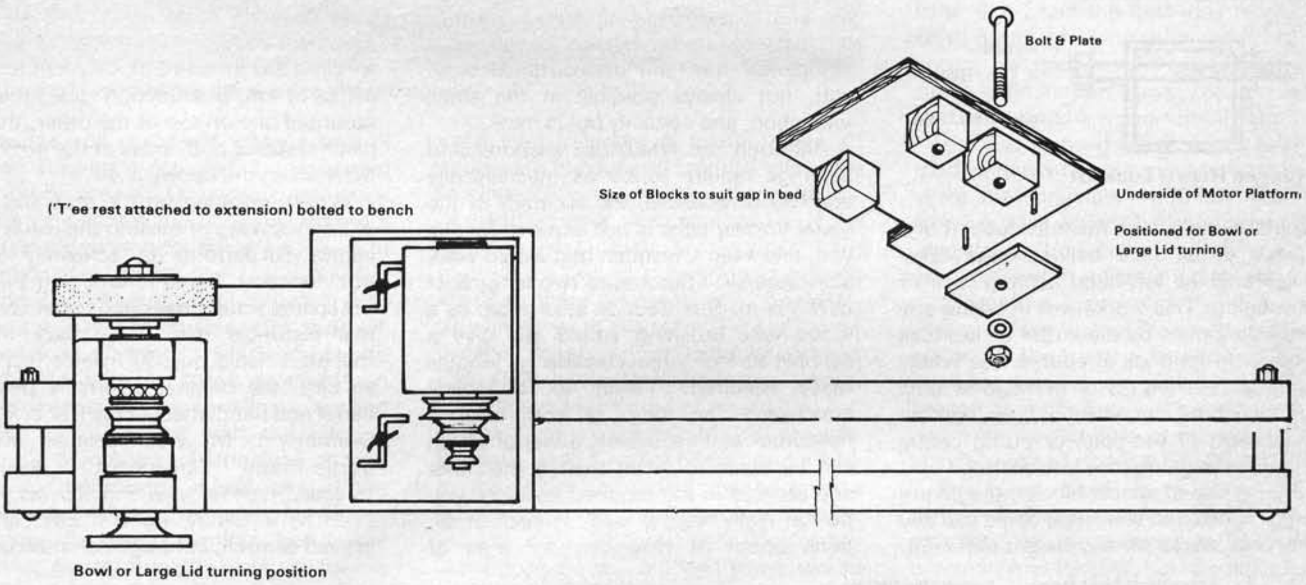
Although the headstock mandrel and bearings require to be as mechanically accurate as possible, the accuracy of the metal turning lathe is not required for the bed, and even a wooden bed would work satisfactorily. I purchased two lengths of S/H 1½ in. Box Section steel tube, as a wood wire brushing would still give a suitable surface when considering what is really required. Taken to a logical conclusion, as long as you have a headstock and a tailstock, either of which can be made to move toward the other and secured in the required position, you do not really need a 'bed' as such at all, think about it! However, for ease of alignment a 'bed' certainly assists, and the simplest bed possible is the best.

With the tailstock I must admit to 'cheating' just a little, although looked at practically, I can still say the lathe was built generally from scrap and off-cuts. The main body of the tailstock comprises simply a 3½ in. and 2 in. slice cut from an offcut of 4 in. Box Section steel tube, and mounted one on top of the other, the low piece stepped both sides at the bottom to fit between the bedways.

Whilst weighing up the pros and cons of various ways of making the usual 'back centre' to perform its 'screwing in and out' function, I was rummaging through my spares scrap boxes and came across a real historical relic. Way back in the 'twenties' (said quickly I don't feel quite so old), the original externally threaded barrel and handwheel of my 3½ in × 30 in. Drummond 'M' was replaced with a home-made 'knockout' internally threaded type and the original was placed aside as a 'handy' item. It has certainly proved as such, although commercially its







shelf life storage charge must be astronomical.

Fortunately, its length exactly suited the 4 in. square tube of the new tailstock, the tube being drilled and bored in the 4-jaw to take two bronze bushes, the front one fitted with a small key to stop the barrel turning with the hand wheel. The wheel itself, which had a flanged boss, was fitted to a split mating hole bored through a 3 in. length of ½ in. × 2 in. Bright flat steel bar, sawn and retained by two screws before boring to form a split bearing like a big end. Reminded me for some reason, of assembling a 'Castles' eccentrics in Swindon's erecting shop before the coming of the Soullers diesel loco. However, such is progress, 'High Speed' trains developed to such an extent that you can't afford to travel on them!

Back to the lathe. The barrel is protected by a piece of copper water pipe held firmly on two bosses turned on the inner faces of both bronze bushes. The front hole through the square steel tube of the tailstock body is larger than the rear hole to allow the 1 in. O.D. copper pipe to pass through, pressing in the rear bush with the pipe in position on the front bush enabled the whole lot to be assembled together, the $\frac{7}{8}$ in. dia. tailstock barrel being protected excellently in use by the copper tube through which it passes.

The use of the tailstock barrel and handwheel has also enabled all of the items of the Drummond to be used if required with the wood lathe, as both tailstocks now have a No. 1 taper socket. Drills and centres are interchangeable and of particular use is the revolving centre, along with the usual tailstock chucks.

Incidentally, with utilisation of facilities in mind and with the possession of a metal-turning lathe, it would be a simple matter to adapt complete, without actual alteration, the tailstock of the metal lathe to fit the bed of the wood lathe. As you cannot use two lathes at once, the use of the metal lathe tailstock with suitable simply attached 'raising blocks' etc., will save the expense and trouble of making a separate tailstock!

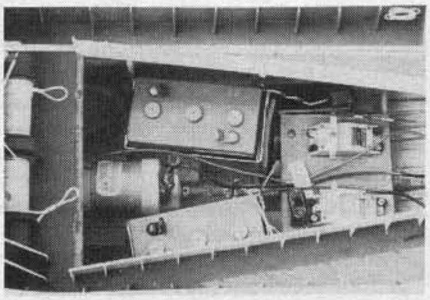
A further interchangeable item is a compound table which readers of Model Engineer may remember I made from an old large lathe topslide and a Myford vertical swivel table, described in the M.E. (Vol. 143-3557). More by luck than judgement (I could say sheer engineering skill, but I only discovered it by accident), I found that the height of the table is just right for the wood lathe and forms a simple compound slide when attached to a plate bolted across the bedways.

I still tend to use 'metal turning' techniques a great deal when doing my limited amount of wood turning, so the slide is useful even with a chisel clamped to it; although wood turners will recoil in horror from the thought. For 'correct' wood turning, the 'T' rest supplied with the Drummond has been simply adapted by bolting onto an offcut of 3 in. × 1½ in. rectangular steel tube, as shown in the photo. It is relatively simple to make a 'T' rest anyway.

However, for less than £10 I now have a 6 in. × 4 ft. centre wood-turning lathe which although it probably will not earn its keep, has proved, as with many things, that when it is required possession is an invaluable asset.

Battery Nomenclature

An introduction to the mysteries of battery terminology—with particular reference to nickel cadmium cells. By John Cundell



1, 2. *This fine stern trawler by David Metcalf, uses lead-acid accumulators, which can be see alongside the motor. The cells are Matsushita 6 volt, 8 amp hr. capacity, and are wired in parallel, the model will run for approximately 70 minutes.*

Electric power has for many years been the predominant source of drive for many forms of model, especially scale ships and boats. An electric motor is much easier for a beginner, avoiding the frustrations of starting and running internal combustion engines, although many run into problems when considering power supplies.

Direct current power can be obtained from:

(i) dry batteries;
(ii) lead-acid batteries;
(iii) nickel cadmium button cells;
(iv) nickel cadmium cylindrical sintered plate cells.

Dry Batteries

Use of these cells, the type available worldwide, is best kept for torches, calculators, radio sets, shavers, etc. — in fact any product which requires a low current drain, generally under 1 amp, usually milli-amps.

They used to be cheap enough, despite their drawbacks, but their vastly increased costs of recent times together with the availability of alternative rechargeable cells has seen their demise for power sources. If one is forced to use them, the higher power (HP) cells are superior and worth buying. However, basically dry cells were not intended for continuous heavy current duties and should only be used as a last resort.

Lead Acid Batteries

The lead acid accumulator used in model work is simply a scaled down version of the car battery known to most. Being comparatively inexpensive, and giving a good output for their weight, they are an excellent choice for powering scale models — so long as they are properly maintained.

They need more attention than any other form of all and suffer quickly and irreversibly if neglected. The following general precautions need to be observed if one wishes to gain maximum usage:

1. The battery should be recharged as soon as possible after use.

2. Rates of charge and discharge should be within manufacturer's recommendations.

One disadvantage is the thought of having liquid sulphuric acid swilling around inside a model — albeit within a plastic case. Recent development though, has brought about a sealed cell which uses a gel instead of acid. This is unspillable and can be installed in a model in any orientation, even upside down!

Nickel Cadmium Cells

This type of cell, also rechargeable, has been around for over 20 years, originally in the form of a button cell, and is used extensively for electronic equipment applications — one example being to power transmitter and receiver in radio control equipment.

The nominal voltage is 1.2 volts per cell, and they may be joined together to form higher voltage packs. The cells are completely sealed, and require practically no maintenance, apart from keeping them dry. Weight is about the same as the equivalent energy source in dry batteries. The only disadvantage is initial cost, some four to five times that of dry cells, plus of course a charging device, between £5 and £13, depending on sophistication. So, nicads and a charger would be paid for after some 10 to 12 battery changes in dry cells.

Initially, rechargeable cells were only available as the button type, manufactured by a German firm called *Deac*; hence the name has stuck, like *Hoover*. These cells are manufacturered in a wide range of capacities, see later, the most useful being 0.225, 0.5 and 1.0 ampere hour.

The second type of nickel cadmium cell, the cylindrical sintered plate variety, has revolutionised electric power, particularly with regard to model boats, cars and aircraft. This type can withstand very high discharge rates and can be recharged at the pondside or flying field with relatively simple charging equipment. The cells are also available in a wide range of capacities , from 0.5 to 10 amp/hr. and are constructed in convenient international sizes which make installation easy, especially if the plastic holders designed for holding dry batteries in cine-cameras, shavers, etc. are utilised.

3. *Three fast-charge nickel-cadmium cylindrical cells and a normal charge rate button cells. The capacities are from left to right, 1.2 amp hr., 0.5 amp hr., 0.7 amp hr. and 0.22 amp hr.*

Nomenclature

To gain full benefit from all these sources of power, it is important that the user has an understanding of the basic electrical terminology employed with battery sources. Don't be put off from reading and assimilating the remainder of this article because of the facts and figures. It is not difficult and will hopefully enable you to get much better value and performance from your power supplies.

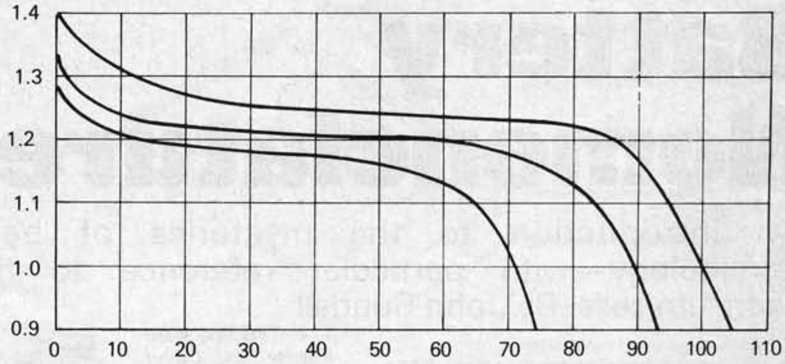
Let us take as an example, a specification such as 1.5v 0.5 A/H at C/5. Everyone understands the 1.5v (1.5 volt) part, and most the 0.5 A/H (0.5 ampere/hour) part, but what does C/5 mean?

C stands for capacity or the total amount of energy which can be obtained from the battery, when fully charged. The nominated capacity, in our example, 0.5 ampere hours, is that which will be obtained when the battery is discharged at such a rate or current as will bring it to a fully discharged state in five hours, hence C/5. This rate of discharge is known as the five hour rate. Similarly C/2 indicates a two hour discharge rate and 3C a complete discharge in ⅓ hour or 20 minutes. Usually, slightly higher capacities will be obtained if the discharge rate is reduced to, say C/10 or C/20, and reduced capacities obtained if discharge rates are increased. The graph shows typical curves for a nickel cadmium cell.

Another way of expressing 0.5 ampere hour is to convert it to amp-minutes, by simply multiplying by 60. Our example of 0.5 ah would obviously become 30 amp mins. Theoretically, it would be possible to take from the battery 1 amp for 30 minutes or 30 amps for 1 minute, or any combination of current and time, which then multiplied, produces 30 amp mins. This statement must be treated with some caution, as the majority of batteries perform best at or near their specified hourly rates, i.e., C/5, C/10, etc. So let's assume we have a small electric motor in a scale trawler, rated at 6 volt, 2 amps. If we fitted 4 of our 1.5 volt cells to give the necessary voltage, the capacity of 30 amp minutes should theoretically give a running time of 15 minutes. The discharge rate would in this case be 4C, which looking at the graph reduces the available capacity to 75 per cent. Hence only approximately 11 minutes running would be obtained.

Charging rates can also be calculated using the amps × mins = capacity formula, i.e., if a 1 amp charger was available and our example battery was completely flat, it would take 30 minutes to reach a full charge. Unfortunately, losses due to heat energy drain, and chemical energy changes within the battery, demand that an extra one-third of the charge is required; in our example another 10 minutes.

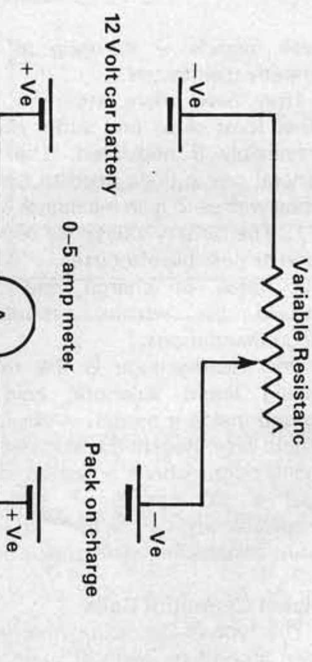
Furthermore, apart from sealed sintered plate nickel cadmium cells, button nicads and lead acids prefer to be charged at a slow rate, usually the C/10 level. Again



Capacity variation with discharge rate % capacity.

taking our example, the 0.5 amp hour, (500 milliamp/hour or 30 amp min.) cell should receive (C) $\frac{500 \text{ milliamps}}{10}$ or 50 milliamps for 10 hours plus one third to make up for losses, i.e., 10 + 3.3 = 13.33 hours which is normally rounded up to 14 hours.

Sealed sintered plate cylindrical nickel cadmium types can be treated entirely differently and are capable of accepting fast charging rates, which makes them the most practical cells for model use. Their performance, rather than being



Simple charger for fast charge Nicads using a car battery.

damaged or reduced by fast charging, as is the case of button cells or lead acids, can be improved quite markedly by fast charging techniques.

Fast charging at, say, the 5 (12C) or 10 (6C) minute rate will after several cycles reduce the internal resistance and increase the capacity of the cell. However, when fast charging certain precautions must be taken to prevent damage to the cells. Firstly the battery should be discharged down to 0.8 volts times the number of cells in the battery. This can conveniently be done by connecting a car headlamp bulb across

4. *An example of the recently introduced lead-accumulators which make use of gel rather than liquid sulphuric acid. The batteries can be mounted in any physical position.*

blocks of up to 10 cells. Secondly, the battery must never be overcharged. In fact, to ensure this, initially it should only be charged to about 80 per cent of its nominal capacity, e.g., for a 1.2 ampere hour cell 0.96 A/H or 57.5 Amp mins. This could be achieved by charging at 5.75 Amps for 10 minutes or 10 amps for 5¾ minutes. If at any time any of the cells can be heard venting, charging must be stopped immediately. Fast charging is most effective when carried out about 1 hour before use, as this allows time for the battery to cool down but very little charge will be lost over this period. In the past it has been suggested that fast charging was done on the basis of stopping when the battery started to heat up. This is not satisfactory as by the time any external heat rise becomes apparent some damage has already taken place. It is not recommended that partially-charged cells be fast charged; these should be charged at the C/5 or C/10 hour rate.

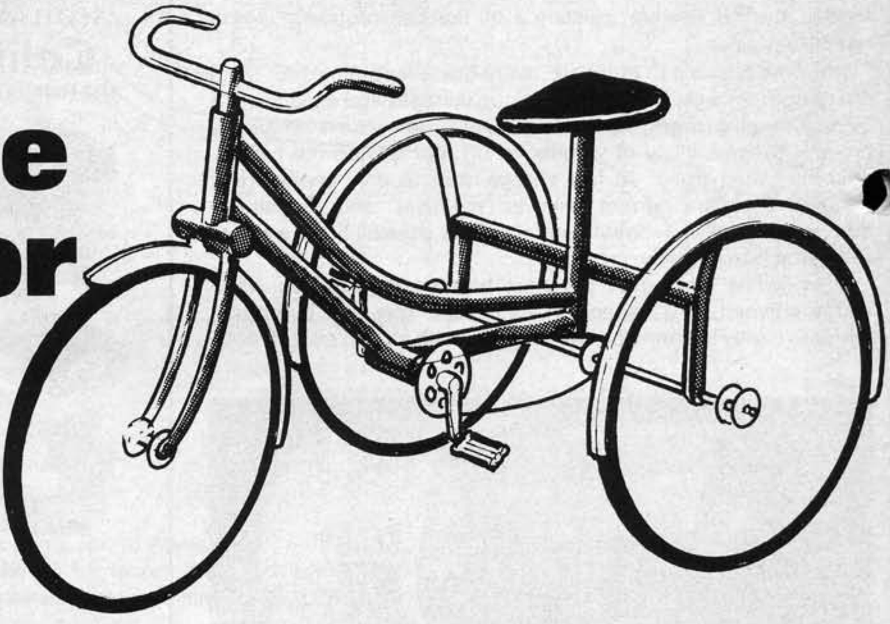
Whilst a number of designs have been published for fairly sophisticated chargers involving constant current circuit, etc., it is quite practical to charge packs of up to eight 1.2 volt cells from a car battery. An old electric fire element and an ex-WD ammeter, 0-5 amps is required. Better than the fire element would be a 0-5 ohm variable resistance, capable of handling up to 100 volts, but these are fairly awkward to come by. It is necessary to time the charging period, of course, and also to monitor the current which, if not reduced by the resistanced, will increase towards the end of the charge. This is caused by the internal resistance of the cell dropping during temperature rise.

It is now possible to purchase ready-made resistances for rapid charging from a car battery for various voltages and capacities of cells. Charging times, usually clockwork, are also available to prevent the possibility of wandering off and leaving the cells to become overcharged. At fast charge rates, it only needs a few minutes over the correct time to 'overheat' and irrepairably damage the cells — notwithstanding the possibility of a minor explosion if severely overcharged.

Also, while looking at potential hazards all batteries when being charged, but especially lead-acids, give off hydrogen, which is highly inflammable when mixed with air. So take care.

The sad result of overcharing a fast-charge cell, distortion of the case and partial melting of plastic sleeve.

Build a Miniature Bicycle or Tricycle



Models to build from old aerials and scrap
by F. C. Smith

HAVING HAD CONNECTIONS with the car radio trade a few years ago, a number of discarded car radio aerials came into the writer's possession. Two of my daughters are keen cyclists, and while examining their machines, the idea of making model bicycles from the car aerials came about. The first two models made were eagerly snapped up by the cycling girls, who wanted them to display on sideboard, or bookshelf. Cycling friends seeing these models, well the reader can guess, it amounted to the writer having to make another four models, for their friends. The making of these models calls for quite a little patience, and the minimum of tools, so it was thought a published description of how to construct them, would help any one who wanted a model for display purpose.

Tools
The basic requirements are few; a set of needle files; a hacksaw; a pair of tinsnips; the ability to solder; and a reasonably high wattage soldering iron, the 25 watt radio iron not having enough heat dissipation to make good non-dry joints, so use a heavy duty iron, for the frame assembly.

Materials
To make either model you require two telescopic chrome car radio aerials; these are made from brass rod, and chromed. The bottom of the aerial is not required, as the frames of the models, to keep the scale correct are ¼ in. dia.

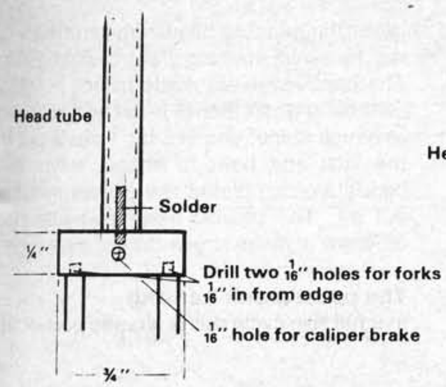
Two wire coat hangers, which are not too hard to come by; one $\frac{1}{8}$ in. dia.; is used for the front and rear forks, and the handlebars. Pick out the straight portion of the hanger for this purpose, clean, and finish with a metal polish to a high shine. The second coat hanger which is one sixteenth dia. is used to make the caliper brakes. An old radio set volume control was used to make the pedal crank housing, which normally is part of the complete cycle frame in a full size machine. After having cut from the body of the control, as shown in the drawing, place in vice and file away the threads; this then was subjected to a high polish, before drilling. The metal shaft of the control is retained, and used to mount the chain wheel and pedals. A 1½ inch. piece of soft copper was used to make the saddle, which is, after shaping covered with thin leather, glued to the seat. The wheels, were made from round tobacco tin lids, the writer being a pipe smoker, had no trouble with that one. The body of the tins were used to make the rear, and front mudguards. The wheel hubs, are made from silvered drawing pins. The drilling of these calls for some care, as they are so small.

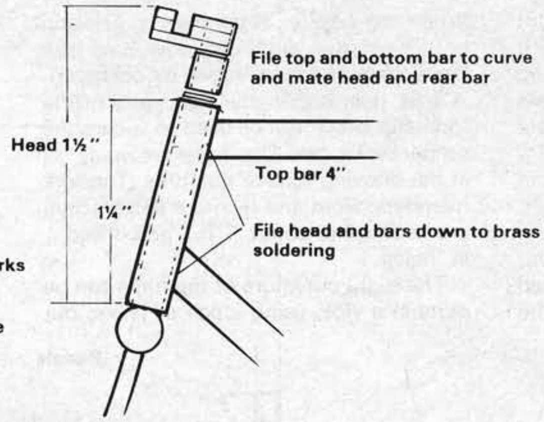
Wheels
Place a lid on a flat board, and file around the outer edge, evenly, until the metal is thin enough to be cut away with the blade of a knife. This then leaves a complete wheel rim, the rough edge around the rim is now filed smooth, and even, away. On the open side of the rim scrape away the paint, and having heated the soldering iron take a length of 20, gauge; tinned wire, 8¾ in. and fit and solder round the rim. Next, on a sheet of drawing paper, draw an 8¾ in. line and mark off 32 spaces at $\frac{9}{32}$ in. Then cut this measurement out $\frac{1}{8}$ in. wide and place around the wheel rim by using an adhesive. Place the rim in a vice as noted in the drawing, make sure to use a piece of wood for support, otherwise the rim could be placed out of true by the pressure of drilling. With a sixteenth drill make the 32 spoke holes, when completed, file any roughness from around the rim, polish, or treat with aluminium paint. Take two silvered drawing pins, place one in the flat board, and drill $\frac{1}{16}$ in. holes evenly spaced, this must be done with some care. Drill an $\frac{1}{8}$ in. hole in the centre, repeat with the second drawing pin. The spindle is $\frac{5}{8}$ in. long and is cut from the top portion of the aerial. Push the two drilled drawing pins on to the spindle with $\frac{1}{8}$ in. of spindle clear at each side. Solder on to spindle.

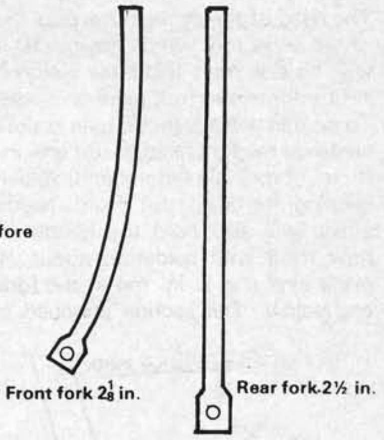
Spoking
The rims are now ready for fitting the spokes. With a sheet of drawing paper place the wheel rim on the paper and draw around the edge, then mark out the exact centre of the circle, place this drawing on the board you are going to spoke the wheel on; place the wheel rim on the circle, taking care the fit is exact, then place four nails; as shown in the drawing to make the rim rigid. Drill a $\frac{1}{8}$ in. hole in the exact centre which you have marked, and push the hub into same, a short nail is then put through the hub to ensure there is no movement when wiring in the spokes. The drawing explains how this is done, do not put excessive tension on the wire, otherwise the wire could snap, or the wheel could be pulled out of centre. A small pair of pliers will help this operation. Having completed one side of the wheel remove the four nails, reverse the wheel and repeat the spoking on the other side. Having completed the wheel it should now run free, and true on its spindle. The wheels on the tricycle are made in exactly the same way. The wheels are now fitted with tyres, these are made from a piece of discarded T.V. co.-ax cable ¼ in. dia. Run an adhesive into the hollow of the rims then having cut 8¾ in. lengths of cable, fit around rim. The wheel is now completed. Leave for 24 hours.

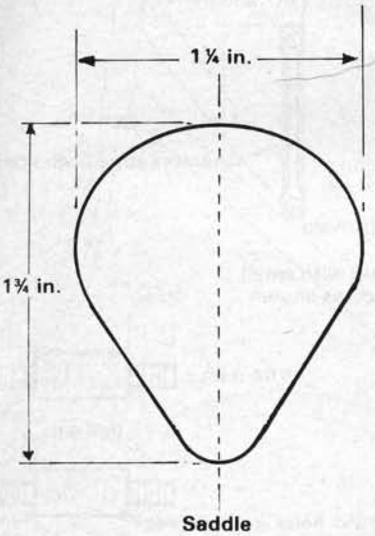
The frame
Having cut and marked out the frame members as in the drawings, they are ready for soldering. Remember all chrome parts must have the chrome removed, by filing before it will take solder. Do this carefully, and only remove the minimum needed to make a soldered joint.

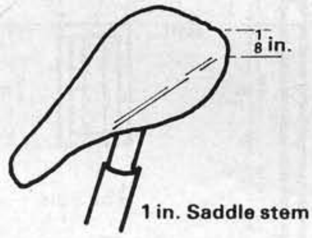
The forks being steel will need Bakers fluid as the flux agent. The top most section of the aerial is used to make the wheel hub spindles as in the drawings.

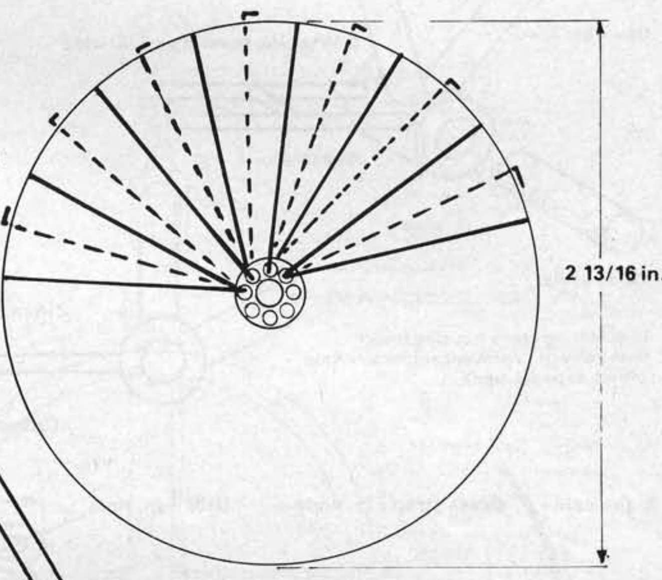






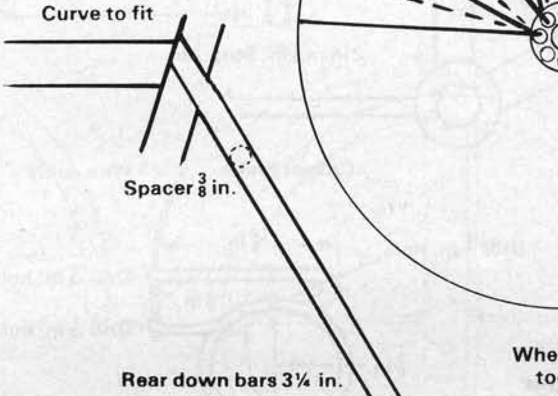


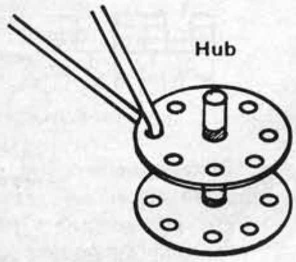




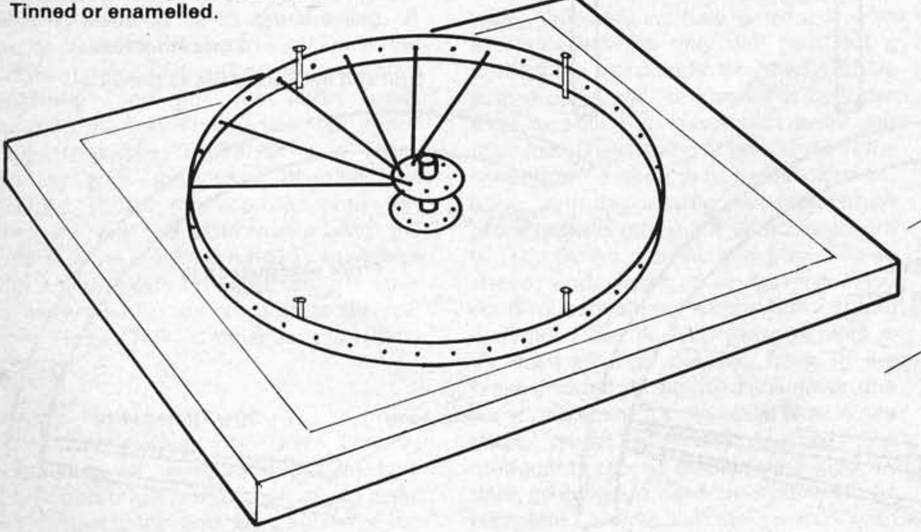
When one side is spoked, twist wire tightly together and press down into wheel rim.

2 yards of wire per rim approximately

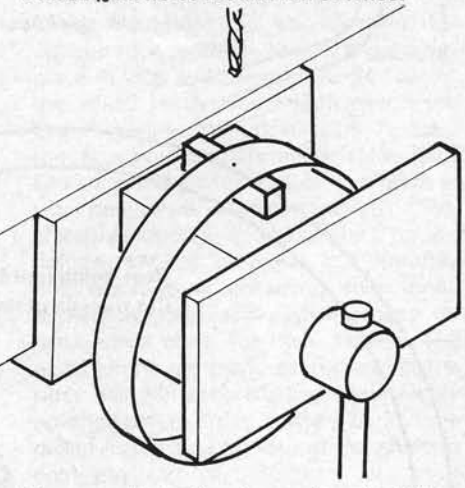




Spoking
Spoke as in drawing, 16 spokes each side.
Wire for spoking 26, or 28 SWG.
Tinned or enamelled.



Drill 32 $\frac{1}{16}$ in. holes around rim of wheel



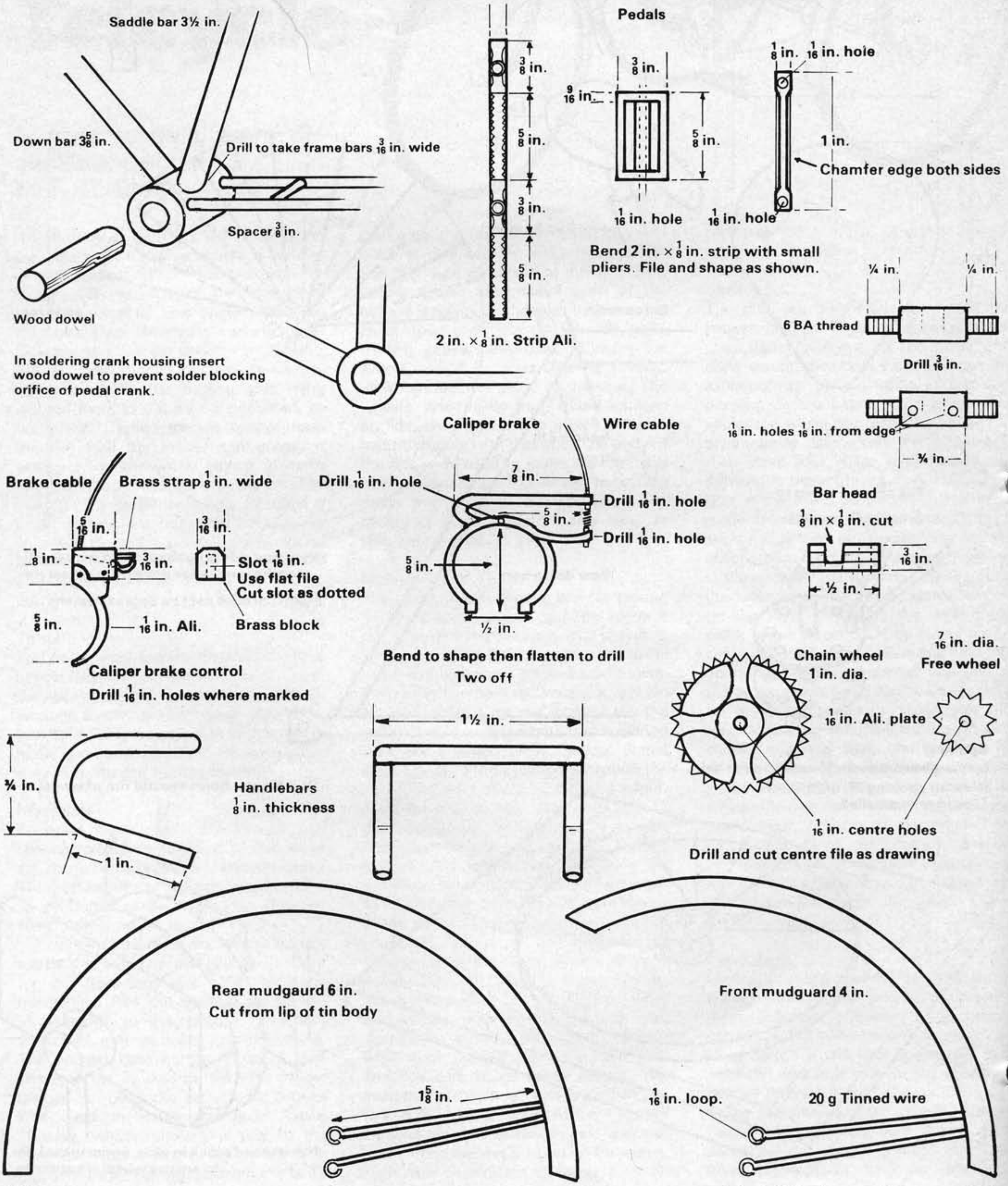
Place wood block in vice, under wheel rim to ensure wheel is kept true.

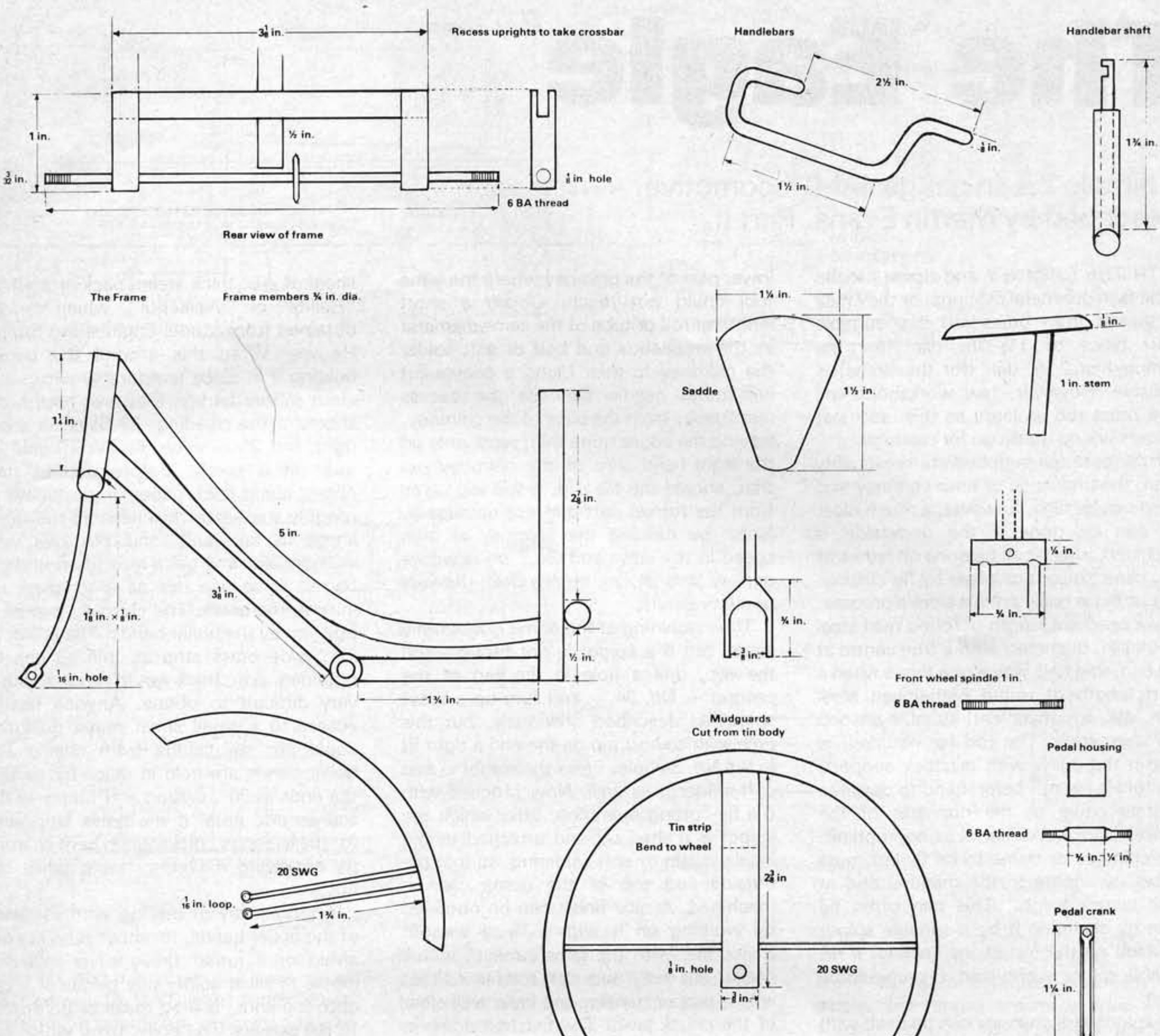
The head of the cycle frame uses the part of the aerial rod, which fits exactly into it with no side play. This inner piece of tube is fitted into the fork head and soldered. To do this drill a $\frac{1}{16}$ th. in. hole in the exact centre of the fork head, insert a ½ in. of $\frac{1}{16}$ th. in. of rod; (tin beforehand) solder, and keeping vertical, the fixed headshaft, which will also hold the handlebars, is now filled with solder to about ¼ in.; place over the ½ in. rod in the forkhead and solder. The section attached to the frame can now be fitted over it. The top portion of the shaft can now have the handlebars attached, again by soldering. A $\frac{1}{16}$ in. hole is drilled in the centre of the forkhead which will be used to secure the caliper brake; two $\frac{1}{16}$ in. holes are made; as in the drawing to take the forks. The fork members; front and rear, are flattened on a small anvil to about ¼ in., and drilled $\frac{1}{16}$ in. holes.

The slight curvature of the forks can be done in a vice, using a pair of pliers, but cover the gripping head with cardboard or rag to avoid marking the polished forks. The handlebars are made from $\frac{1}{8}$ in. dia.; coat hanger, six inches is cut and polished to a high shine, and like the forks is put in the vice and bent to shape, when the bends are completed the excess metal is cut off. The tricycle bars are made in a different style as shown in the drawing.

The pedal crank housing

In a full size cycle this is already part of the





Tricycle components.

frame, but in a model it has to be made separate. This item is as explained made to the measurements in the drawing. Having prepared the cross bar, and down bar, ready to solder, place the completed fork assembly in the vice (between two pieces of flat wood). Take the top bar and solder same to head shaft. The down bar is then soldered as in the drawing. A paper template is used to maintain the correct angles of the bars. Remove after soldering, and put the pedal crank housing in vice. The vertical bar which holds the saddle is now soldered in. Then, making sure the frame alignment is correct, solder the top bar onto this vertical, and the bottom bar into the recess in the crank housing. The two rear forks are next fitted, then the two downbars which are soldered to the rear fork ends. This completes the frame assembly.

Pedals

These are made to the drawing measurements, using a $\frac{1}{8}$ in. by $\frac{1}{16}$ in. strip of ali. Serating the tread part of the pedal with a needle file, and using again the top part of the aerial for the centre shaft, which will take a 6BA nut and bolt to mount on pedal shaft.

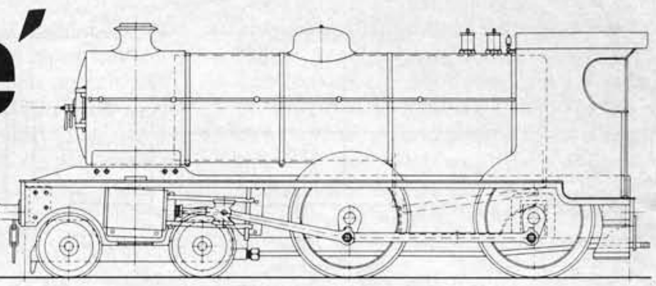
Caliper brakes

Use 3 inches of the $\frac{1}{16}$ in. coathanger; having polished same first, place on small anvil and flatten the centre about $\frac{1}{8}$ in. wide, drill a $\frac{1}{16}$ in. hole in centre, it is advisable here to only drill to about a third of the metal and make the final hole with a panel nail, because it is only too easy to split the metal with such thin diameter. The shaping of both sides of the brake can be done with a pair of pliers. Make as in the drawing, the second part of the brake is now made with 2 in. length of rod; flatten the one end $\frac{1}{8}$ in.; drill as above, and shape as in drawing. Two small rubbers are cut for the brake blocks and glued on. A 28 g piece of wire is threaded through the two holes in the brake and fed to the handlebar lever, the same procedure for the rear brake. When either model is finally finished, the mudguards can be painted with gold, or dark green paint. The underside of the completed saddle can be painted with black enamel paint. To display the finished bicycle the writer made a wood stand of oak varnished 9 in. by 2½ in. wide by ½ in. thick, and a small signpost was fitted in the centre to use as a holding support for the cycle.

The chain wheel, and free wheel

They are cut from $\frac{1}{16}$ in. dia.; ali; plate, drill out the four sections, as in the drawing, place in vice and using a needle file cut the wheel teeth evenly right round the chain wheel to a depth of $\frac{1}{16}$ in. To keep the teeth even depth round wheel scribe a line in from the edge to $\frac{1}{16}$ in. Cut teeth in rear free wheel in same manner. The writer had enough miniature chain for the first two models he made, but one may find difficulty in obtaining such small dimension chain, although Meccano do make small chain for their models. The pedal shafts are made as in drawing the sides being chamfered, and again highly polished before fitting, and a $\frac{1}{16}$ th. in. hole drilled in top and bottom of the shaft to complete.

The 'Eagle'



A simple 2½ in gauge 4-4-0 locomotive. Described by Martin Evans. Part II.

BOTH THE CHIMNEY and dome can be made fron gunmetal castings, or they may be turned from brass rod if a suitable short piece of 1½ in. dia. (for the chimney) or 2 in. dia. (for the dome) is available. However, few workshops will have brass rod as large as this, so most builders will no doubt go for castings.

If the castings supplied are reasonably clean, the underside of both chimney and dome can be filed; however, a much nicer job can be done if the underside is machined, which can be done on lathes of 3 in. centre height or larger by fly-cutting. Fly-cutting is really quite a simple process. All we need is a length of round mild steel about 1 in. diameter, with a true centre at one end, and half-way along this is fitted a short length of round high-speed steel ($\frac{3}{16}$ in. dia. is convenient) suitable shaped and sharpened. The rod (or mandrel) is held in the 3-jaw with tailstock support. The tool is set out beforehand to describe a circle equal to the diameter of the smokebox or boiler barrel as appropriate. The chimney or dome to be fly-cut must be set up square to the mandrel and at lathe centre height. This can often be done by clamping it by a suitable spigot provided on the top of the casting. If no suitable spigot is provided, one should be fitted.

A spigot-less chimney can be dealt with as follows: chuck the casting and set it to run as truly as possible, underside outwards. Bore it out to a nice tight hand push fit over the petticoat pipe. Now turn up a length of brass rod a good fit in the chimney, and long enough to project through the top by a good 2 in. The brass rod should, if possible, be a tight hand push fit in the chimney — if too tight it may be difficult to get the chimney off again without damaging it; if too slack, soft solder it.

File a flat on the projecting brass rod, the chimney can then be clamped under the lathe toolholder by this, and set to centre height.

When fly-cutting, take very light cuts at medium speed, this being done by advancing the cross-slide towards the cutter, the saddle being moved from side to side as machining proceeds.

Having completed fly-cutting, transfer the casting to the 3-jaw, holding it by the spigot and turn the outside as far as the tool can reach. A normal parting tool with the front face ground quite square, plus a similar tool with both edges radiused at about $\frac{1}{16}$ in. radius will be found ideal for chimney turning. We now have a rather ticklish hand-filing operation to finish the lower part of the chimney where the lathe tool could not reach. Obtain a short length of rod or tube of the same diameter as the smokebox and bolt or soft solder the chimney to this. Using a coarse-cut half-round needle file, file the excess metal away from the base of the chimney, leaving the edges quite thin; work only on the right-hand side of the chimney, so that, should the file slip, it will slip away from the turned part and not damage it. Finish by running the chimney at high speed in the lathe and work on it with a narrow strip of fine emery cloth (beware of cut fingers!).

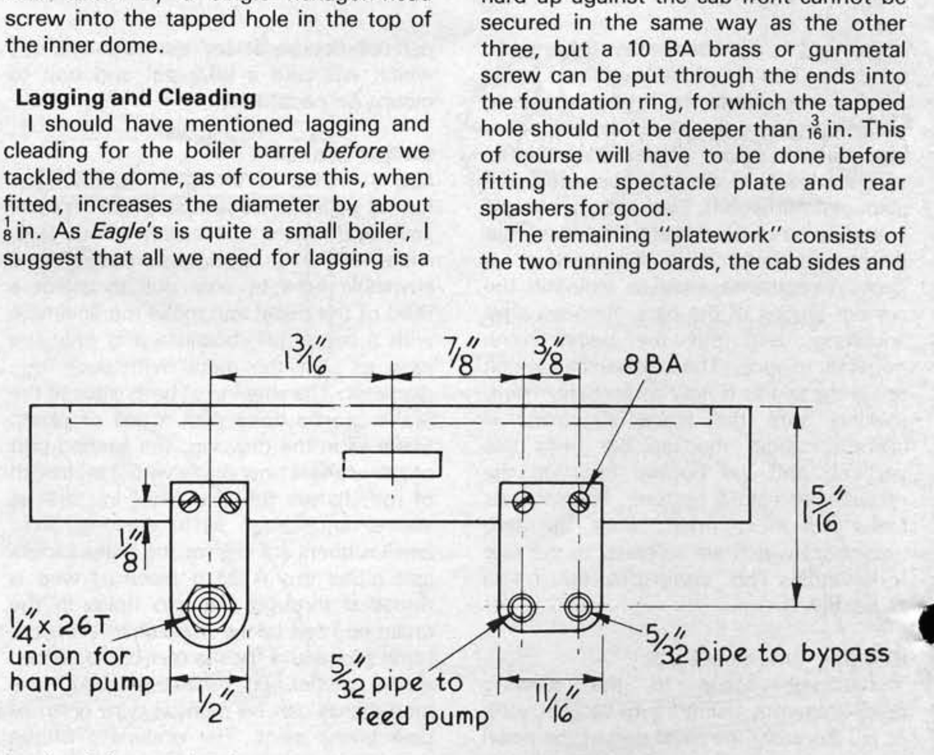
The machining of the dome is much the same, but if a spigot is not provided on the top, drill a hole in the top of the casting — No. 34 — and turn up a brass spigot as described previously, but this time with a short pip on the end a tight fit in the No. 34 hole. Press the spigot in and soft solder it as well. Now proceed with the fly-cutting operation, after which the spigot is melted off and attached to the inside, again by soft soldering, so that the outside and top of the dome can be machined. A nice finish can be obtained by working on it with a dead smooth Swiss file, with the lathe running at full speed, but make sure that the file is fitted with a proper handle, and keep well clear of the chuck jaws! The finished dome is held down by a single hexagon-head screw into the tapped hole in the top of the inner dome.

Lagging and Cleading

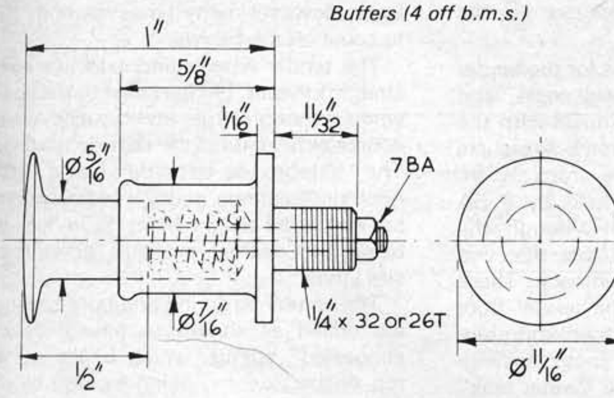
I should have mentioned lagging and cleading for the boiler barrel *before* we tackled the dome, as of course this, when fitted, increases the diameter by about $\frac{1}{8}$ in. As *Eagle*'s is quite a small boiler, I suggest that all we need for lagging is a sheet of $\frac{1}{32}$ in. thick steam packing such as "Hallite" or "Walkerite", which can be obtained from Model Engineering Supply Houses. Wrap this around the barrel, holding it in place temporarily with some stout rubber bands, then use hard brass sheet for the cleading, 28 SWG is about right, but 26 or even 30 SWG could be used at a pinch. Before cutting this, obtain some thick paper or cardboard of roughly the same thickness as the brass sheet to be used, and cut this with scissors, so as to get a nice fit around the barrel. Then use this as a template for cutting the brass. The cleading is held in position by the boiler bands. These can be $\frac{1}{8}$ in. wide brass strip as thin as can be obtained. $\frac{1}{64}$ in. thick would be ideal, but is very difficult to obtain. Anyone having access to a small sheet metal guillotine could cut the bands from sheet. The boiler bands are held in place by turning the ends at 90°, drilling and fitting 10 BA screws and nuts. If the brass strip used for these bands cracks when bent sharply, try annealing it first, or bend while still hot.

Another way of dealing with the ends of the boiler bands, for those who are not afraid of a rather fiddly silver-soldering job, is to silver solder tiny pieces of angle onto the ends, drilling these as before for 10 BA screws. The boiler band which lies hard up against the cab front cannot be secured in the same way as the other three, but a 10 BA brass or gunmetal screw can be put through the ends into the foundation ring, for which the tapped hole should not be deeper than $\frac{3}{16}$ in. This of course will have to be done before fitting the spectacle plate and rear splashers for good.

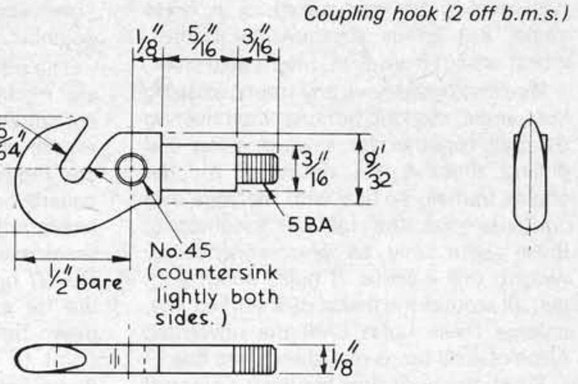
The remaining "platework" consists of the two running boards, the cab sides and



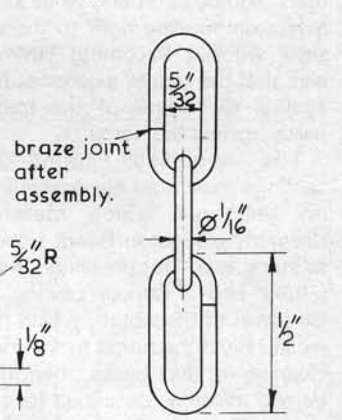
Details of pipes on drag beam.



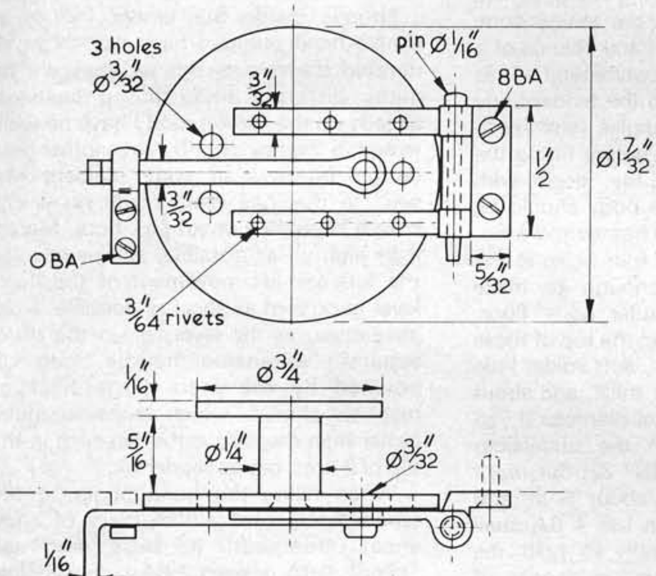
Buffers (4 off b.m.s.)



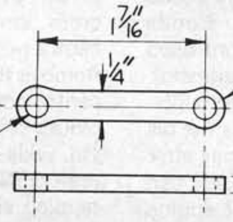
Coupling hook (2 off b.m.s.)



Coupling links (2 sets off b.m.s.)



Details of firedoor



Engine tender coupling

splashers, and the cab roof. These can all be cut from 18 SWG hard brass sheet. The running boards are supported by the flat top of the buffer beam and the drag beam, and they also receive support near the middle from the top edge of the motion plates, so the end screws will be sufficient to hold them in place. The running board edging, valance, hanging bar — call it what you will — can be soft soldered, plus just enough brass rivets or small brass screws to hold things together while the heat is applied. The cab sides are held to the running boards by ¼ in. × ¼ in. brass angle. This is best attached permanently to the cab side, by riveting or soft soldering, screws being put through this into tapped holes in the running boards or the beams beneath them, as appropriate.

Underneath the engine drag beam, we have three pipes; on the left — a ¼ in. × 26T union for the connection from the tender hand pump, and on the right, two $\frac{5}{32}$ in. plain pipes, one for the feed from the tender to the axle-driven pump and one for the by-pass, or return to the tender. These are all held rigidly by the brackets shown, screwed on to the drag beam. Their opposite numbers on the tender will need a little flexibility, especially that from the hand pump, as this pipe will be under full pressure when the pump is being used. This is allowed for by a double coil in the pipe below the tender, as shown.

The buffers and couplings can be tackled now. The former are straightforward turnings in mild steel, but note that they are held firmly to their respective beams by a nut on the back; when we come to the tender, we find that due to the much wider spacing of the frames, the shanks of the buffer bodies only just clear the inside of the frames. However, we can get over this problem by filing one side of the nut used on the buffers until it just clears the frame, which means that the buffers (on the tender) must be fitted to the beam before attaching the beam to the frames. The coupling hooks call for a little careful sawing and filing, while the links should be bent up on a simple jig. Ordinary $\frac{1}{16}$ in. dia. mild steel can be used for the links as this is easy to bend. All we need in the way of a bending jig is a "slab" of steel with two $\frac{5}{32}$ in. dia. silver steel pins pressed into it at the desired spacing. A little practice will soon produce shapely links; but note that the ends must be brazed, as $\frac{1}{16}$ in. dia. wire might easily be pulled open by a powerful 2½ in. gauger.

Before we leave the engine itself, there is one more component to deal with — the firedoor. This is best made from mild steel, as brass conducts the heat too easily. The hinges are made from $\frac{1}{8}$ in. square material, as it would be very difficult to bend the end of thin strip into a complete circle at the "pin" end. Drill the $\frac{1}{16}$ in. dia. hole first, round that end, then saw or saw and file away to leave the strap part a bare $\frac{1}{32}$ in. thick. Rivet to the door with $\frac{3}{64}$ in. dia. rivets. The hinge block can be made from $\frac{5}{16}$ in. × ¼ in. steel or brass, or the nearest available, again a sawing and filing job. It is held to the boiler backhead by two 8 BA brass or gunmetal countersunk screws. The handle or lever is made from $\frac{1}{16}$ in. steel, with a $\frac{3}{32}$ in. dia. pivot pin, while the catch can also be made from $\frac{1}{16}$ in. steel, using two 10 BA screws to hold it to the backhead.

The Tender

My outline drawing of the tender shows a strong resemblance to that fitted to the G.N.R. (Ireland) 4-4-0s, and it is a very easy tender to make, particularly as I have omitted those splayed out rear corners which might have caused beginners (and perhaps some more experienced builders) a bit of trouble! In fact the tender sides and back could be made in one piece — material again 18 SWG brass — but I think beginners will find it easier to make sides and back separately and join them with more of that useful stuff, ¼ in. brass angle. But let us start on the frames, which are cut from $\frac{3}{32}$ in. bright mild steel.

No-one should have any trouble making the frames, marking out one, then riveting the pair together for sawing, filing and drilling together, as described for the engine frames. To deal with the large oval "cutouts' (on the full-size locomotive, these were only to save unnecessary weight) drill a series of holes about $\frac{3}{32}$ in. dia. all around the inside of a scribed line, enlarge these holes until the unwanted piece of steel drops out, then file to line.

Finish the horn slots by using a piece of $\frac{3}{8}$ in. square mild steel as a gauge, but note that before sawing these slots out, it is a good plan to drill the holes shown in the corners, which makes for a stronger job than "square" corners, while allowing the axleboxes to slide right to the top of the slots without becoming jammed. Note also that the tender axleboxes bear partly against the edges of the frames and partly against the horns.

The combined "spring & horn" castings shown on my drawing are based on the type which Messrs Bonds (formerly of Euston Road, London) used to stock as a "hot-pressing" in gunmetal. I have had a sample casting from Mr. Goodwin of Blackburn, which fills the bill nicely. Rivet the horns to the frames after cleaning up their backs, then the slot can be end milled as described for the engine horns. They could also be filed, again using the $\frac{3}{8}$ in. square steel as a gauge. While a reasonably good fit should be aimed at, we don't need to be quite so "precision" on the tender; as on the engine.

The front and rear beams for the tender are made from ¾ in. steel angle, and construction is almost identical with the engine drag beam. Two frame stretchers are required, being made from ¼ in. square brass. These are held by 8 BA hexagon-head screws put through the holes seen in the frame. Note that two No. 27 holes are required in each. These are for screws to hold the tender floor down firmly. Now there is an important point to watch here. As these holding-down screws come in the "water-tank" area, we cannot use just plain 4 BA screws and nuts. We want a strong fixing, yet we must be able to detach the tender body from the frames without any chance of a leak. The method I recommend is as follows: after making up the tender body using ¼ in. brass angles and soft-soldering all seams, but *before* fitting the sloping coal plate or the top "deck" with the water manhole, the body should be aligned in place over the frames and a No. 27 drill put through the four holes in the cross stretchers just enough to make centre-pops on the tender body floor. Remove the body, and on the top of these centre-popped positions, soft solder little blocks of brass, say $\frac{3}{8}$ in. thick, and about $\frac{3}{8}$ in. wide and long or $\frac{3}{8}$ in. diameter if you prefer. Now drill from the underside, tapping size for 4 BA (N° 32) *but don't go right through*, go in about ¼ in. and tap 4 BA. We can then use 4 BA steel screws of suitable length to hold the tender floor firmly with no danger of leaks, however many times the body has to come off the frames.

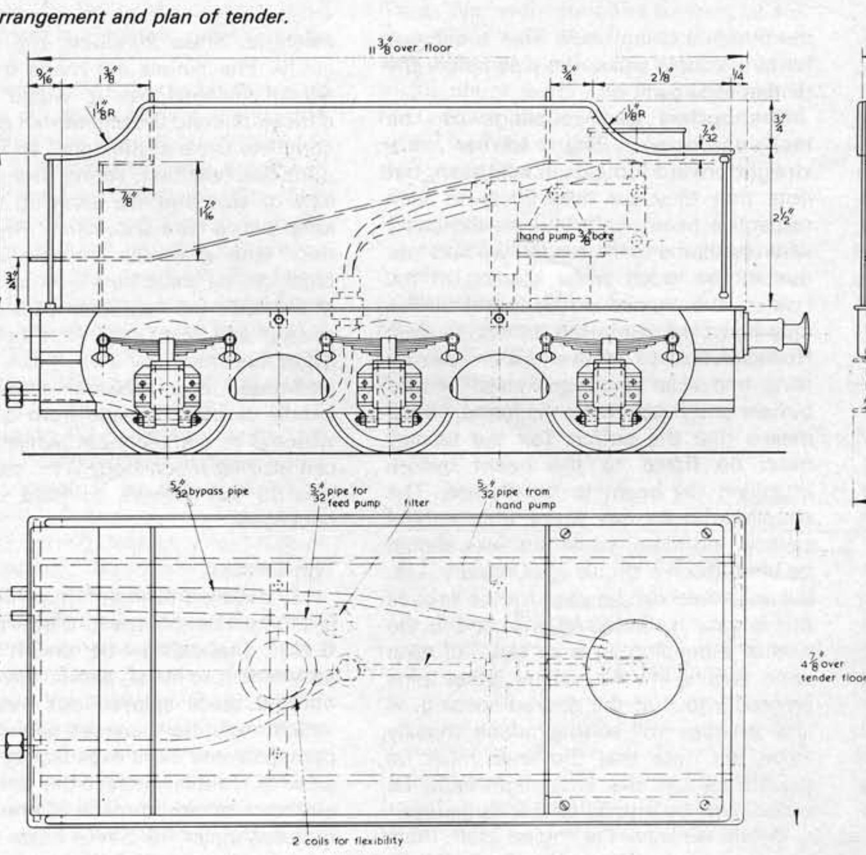
The tender wheels and axles are quite straightforward, being similar to the bogie wheels, though larger and the axles are of course extended for the outside bearings. The axleboxes can be made from gunmetal castings, though ordinary brass bar would be alright here, ¾ in. × ½ in. being the nearest available commercial size I think.

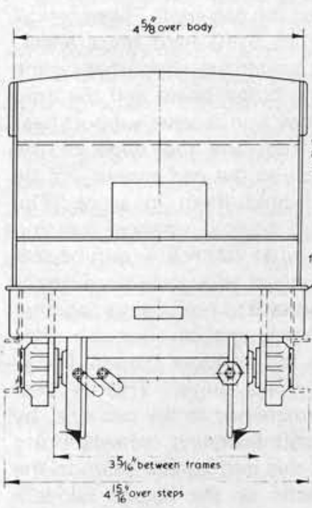
The combined spring and horn castings are drilled as shown to take a "semi-concealed" spring, which bears on the top of the axlebox, being located by the $\frac{5}{32}$ in. dia. hole shown. For the springs, 24 SWG should be about right.

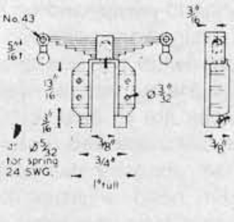
Fittings inside the tender include a simple hand pump. I have not shown a detailed drawing of this as there are so many different hand pump castings already on the market, and I have no wish to add to their number by yet another new design! In any case, some builders may wish to buy one ready-made, in which case it should be about $\frac{3}{8}$ in. bore. Mount it as high up as possible, as this enables the fore-and-aft movement of the hand lever to be kept as short as possible, a big advantage, as the lever, given the usual separate extension handle, can be covered by the extra large filler or manhole shown, which looks so much better than the long slot often seen in the top of 2½ in. gauge tenders!

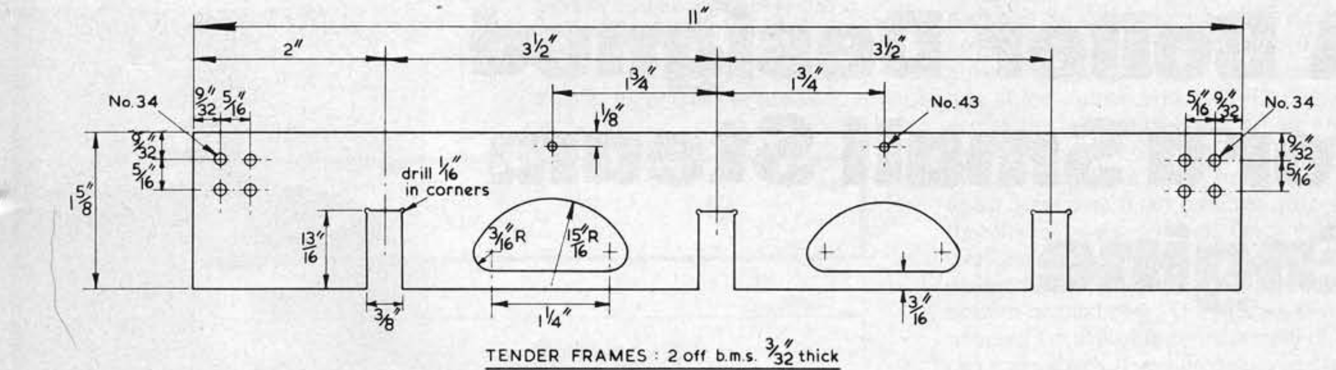
When fixing the hand pump to the tender floor, inset a thick piece of brass sheet underneath its base, and use "blind" 4 BA or even 2 BA tapped holes,

General arrangement and plan of tender.

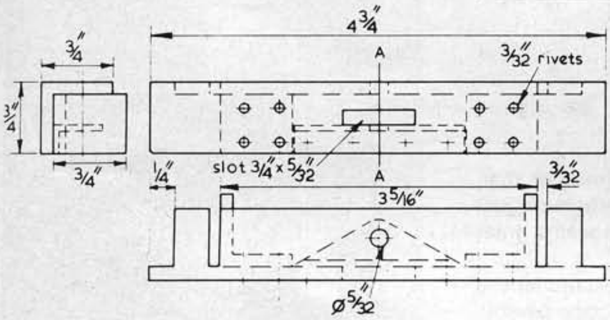


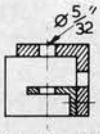






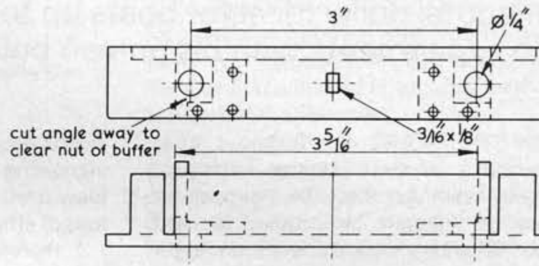
TENDER FRAMES : 2 off b.m.s. 3/32" thick





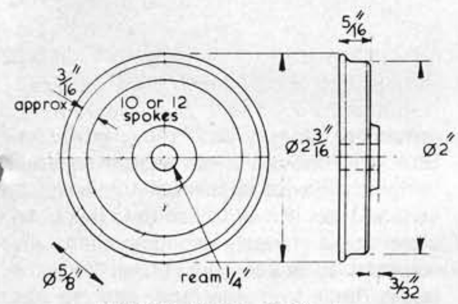
Section AA

TENDEN DRAG (front) BEAM

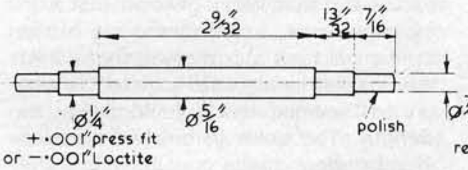


TENDER BUFFER BEAM

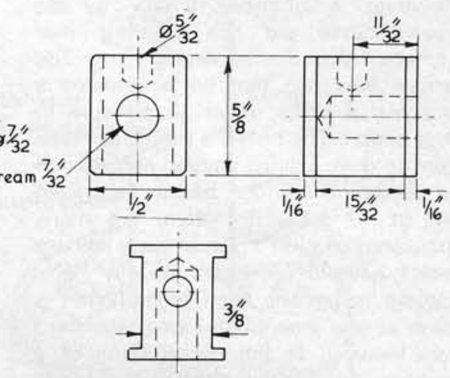
dimensions not given as for drag beam.



TENDER WHEEL: 6 off c.i.

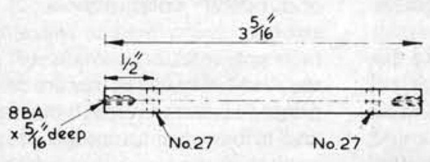


TENDER AXLE : 3 off ground m.s.

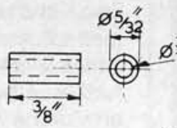


TENDER AXLEBOX

6 off gunmetal or brass



TENDER FRAME STRETCHERS: 2 off brass



HORNSTAY (for Ø3/32" pin)

6 off brass or steel

so that the fixing screws can be put in from above without having to pass right through the tender floor.

The pipe ($\frac{5}{32}$ in. dia.) from the hand pump is connected to a double union fitted to the floor. In other words, there is a male and female union fitting on both sides of the floor, so that the pipe from union to pump can be removed without removing the pipe from union (underneath) which runs forward to make the connection to the engine, as described previously.

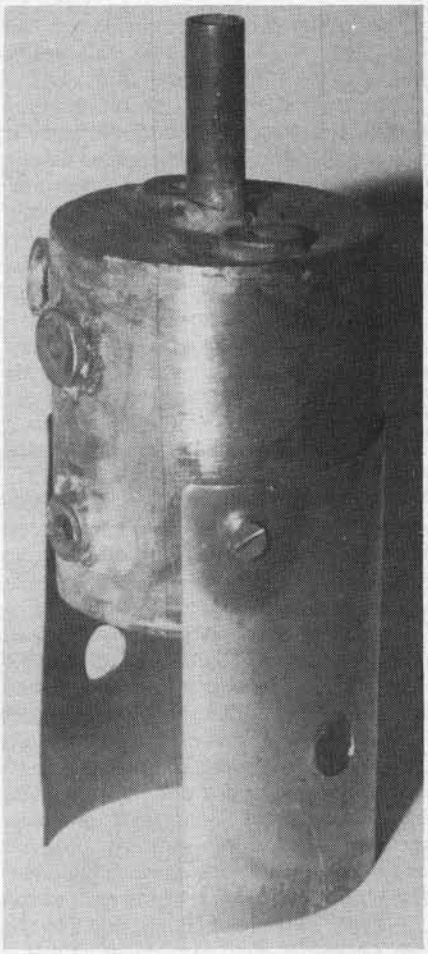
The pipe collecting the water for the axle-driven pump is fitted in a similar manner, but it ends in a filter. This can be made very easily by wrapping round a piece of that fine gauze as used in carburettors etc., fixing it with a touch of soft solder. The bypass pipe is brought up inside the tender body in a similar manner, and is arranged to end just below the manhole, so that the driver can see whether the axle-driven pump is working properly by simply removing the manhole lid.

That completes my notes on building the locomotive; so may I conclude by a few notes on painting. I would suggest a dark olive green for the main body parts of the engine, leaving the smokebox, the tops of the running boards the cylinders, the outsides of the frames and the cab roof black. The insides of all frames should be red (Vermilion) and the inside of the cab would look nice in a buff colour. However, these are just my own preferences; if any builder prefers a maroon or dark blue finish, good luck to him!

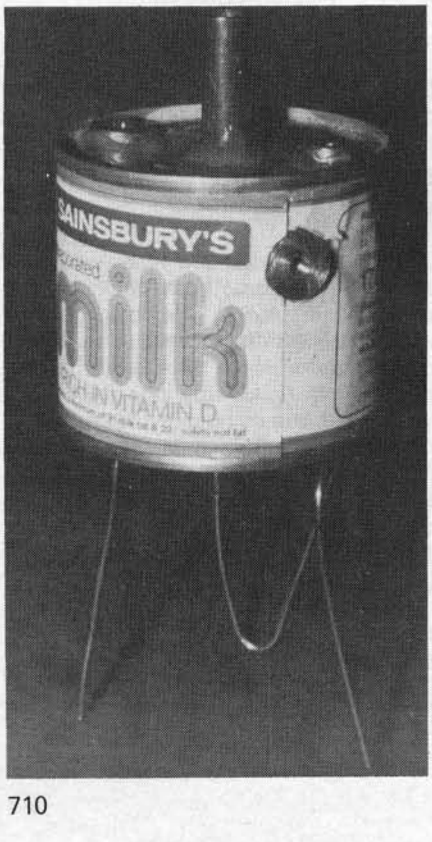
The tender sides and ends would of course be the same body colour as the engine, with black inside, black frames and wheels. Buffer beams vermilion of course, buffer heads black or left bright, as preferred. As for lettering, many types of transfers can be obtained from Reeves of Birmingham, though for those with the necessary skill (and patience) hand lettering looks even better. If transfers are used, don't forget that the proper quick-drying varnish is essential, and the thin paper backing of the transfer letters should be washed off very carefully by a thin stream of cold water — never try to pull it away with the fingers! A thin coat of good quality varnish will complete the job. Good steaming!

A Boiler Designed for a Small Steam Engine

Stan Bray shows how to construct a vertical and horizontal boiler ideal for boats up to 30 in. long, also experiments with his tin-can boilers.



OVER THE YEARS the boilers I have made have all been of the traditional designs whether they be vertical or horizontal. All were constructed by hard soldering and giving at least an eight times safety factor. it was only natural that when asked to design and make a boiler to drive a small oscillating engine I should think along the same lines. However a chance remark by an acquaintance set me thinking that perhaps I was on the wrong track. The remark was one that he had tested a commercial boiler under air pressure to destruction. The boiler, a simple pot type used to drive a small traction engine with an oscillating cylinder, had in fact given out at 10 p.s.i. But there are many thousands of such boilers in every day use and I have never heard of any harm coming to anyone from them. What is more at one time when I was teaching I was involved in the construction of a number of oscillating engines and found that if pressure was too high rather than increasing the power of the engine it just blew it off it's seat and there was a great loss of efficiency.

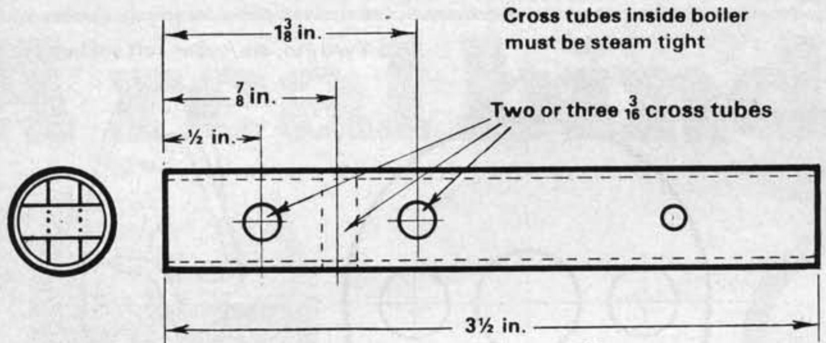


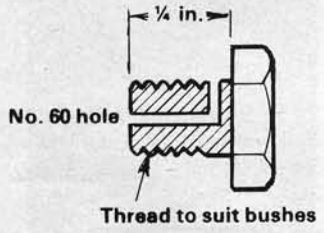
I therefore decided to experiment a little. There has been considerable discussion in a magazine regarding the possible use of a tin can as a boiler. Well the pot boiler referred to was only soft soldered and so only really a tin can, if that worked then was it possible that a tin can might work, too. Examination of the commercial food can showed that whilst it was indeed only soft soldered it was very well seamed which would give some strength. The holes in one were sealed off, a pressure gauge connected and the compressor started it gave out at 25 p.s.i. which was two-and-a-half times that of the commercial product. Just to make sure two others were tried, one failed at 17 the other at 28. So assuming that the engine was only going to work at about 7 or 8 p.s.i. we had a safety factor of about two. But what of the effect under steam? A can was half-filled with water. A gauge fitted and all holes sealed off. A small meths burner was put underneath and the gauge went to 6 p.s.i. but would go no further. Obviously then the burner itself provided a safety factor in that it would not let the boiler gain too much pressure. Next it was tried with a Gaz blow lamp. at 15 p.s.i. the seam at the side became unsoldered and the thing leaked. Another try with a smaller flame produced a similar results at about 25 p.s.i. More experiments showed that certain tins would in fact stand about 50 p.s.i. and it was reasonable in the circumstances to assume that such a tin properly prepared would easily act as a boiler at pressures of up to 10 p.s.i.

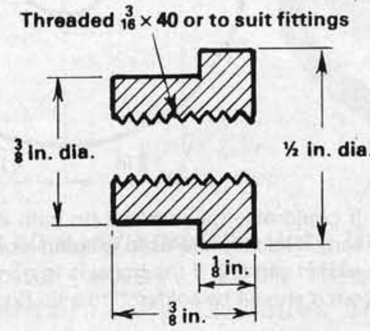
A proper chimney was inserted into a tin with cross tubes and the bottom heated. It happily steamed away at 8 p.s.i. which was the pressure to which the safety valve was set. The valve was removed and the hole sealed and at 40 p.s.i. one of the seams opened and that was the end of my boiler. I had found out, however, that it is possible to use a tin as a boiler providing one is sensible about it and does things the right way, and providing one picks the right tin. Strangely enough there seems to be a better chance of success if the boiler is vertical than if it is horizontal. Being tin plate it is much stronger than the commercial wafer thin brass and the ridges built into the end add to the strength.

Having run out of tin cans, I now set about the construction of a much stronger boiler which will stand a very high pressure, and which will do the job very well. However, before this article is printed I hope to remake the tin can boiler and to have a photograph of it in action, so that anyone wishing to do things really on the cheap can do so. The main boiler which I am about to describe is also vertical. For this sort of work the vertical boiler does have advantages. However, a drawing is shown of a horizontal one for those who wish to make one but there are difficulties in soldering in the water tubes and for the man who is not too keen on soldering then the vertical one is easily the best bet.

Past experience had shown that to run an oscillating engine for ten minutes or so very little water was required and the boiler could be very small indeed. The one shown should easily drive the engine for a quarter-of-an-hour before refilling. The usual way of filling the type of boiler on the small commercial models is to remove the safety valve and pour water in. This is difficult when things are hot and so provision is made for a pump. This can either be a hand pump or as will be







explained later it is possible to make an automatic electric pump. If the boiler is to be used for anything other than a boat then probably a mechanical pump could be fitted. I intend to use the one I have built to drive a steam wagon and a pump will be fitted to it.

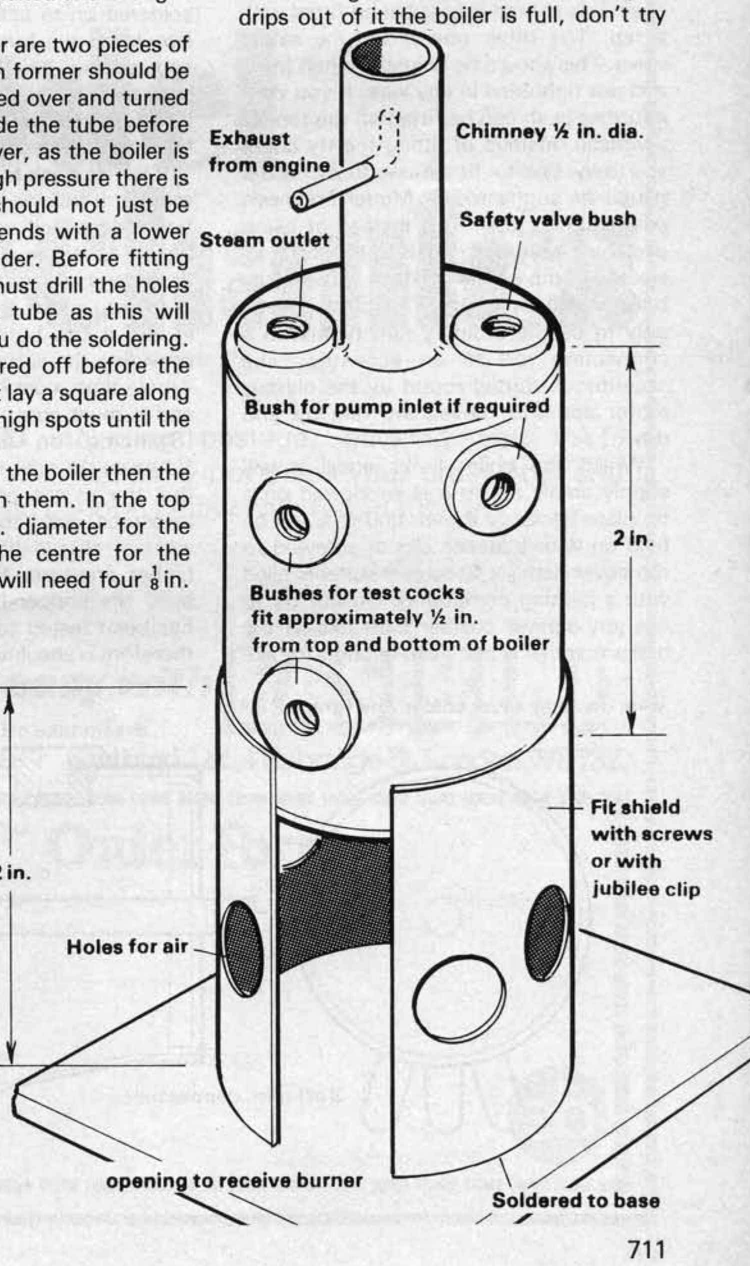
Boiler

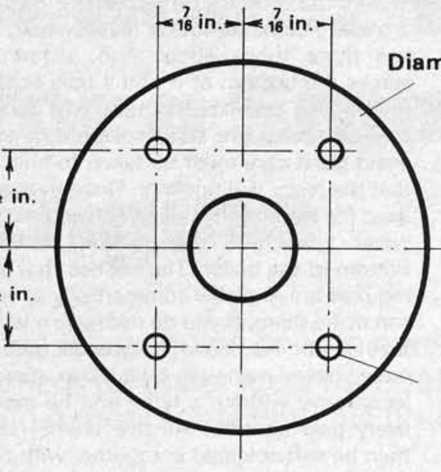
This is really only a small copper pot with a central flue. There are cross tubes in the flue, which will increase the water heating capacity. A meths burner of the evaporation type is put underneath. (If you make a tin can boiler do not use this type of burner). The steam is taken from the top. The steam tube can be brought back through the flames of the burner for a form of superheating and the exhaust from the engine should be made to travel up the flue. The main boiler section is a piece of tube two inches diameter by two inches long. Ideally about 22 or 24 gauge copper should be used. Anything heavier tends to create too much heat loss. If you do not have any tube then a piece of sheet can be rolled round a former, and the seam which should overlap can be silver soldered using a fairly high melting point solder as there are other joints to be made and we do not want the seam to come undone when we do these. A good way to get a piece of sheet is to get a length of ¾ or 1 in. copper tube about 6½ in long, cut it lengthways and open it out. It can now be rolled the other way into the right size tube. To roll the sheet into tube it needs to be well annealed and to be pulled round a former. I usually do this with jubilee clips but it can easily be done by hand if the sheet is really soft or can be pulled in with iron wire of the sort that the coat hangers you get at the cleaners are made from. The former can be of either wood or metal. If you do not have a suitable piece then get the cardboard tube from inside a toilet roll. Fill it with plaster to make it rigid and then increase the diameter by rolling paper round it. Finally finishing with a liberal sticking down with sellotape. The seam must be a good one so make sure it is well fluxed and brought well up to temperature.

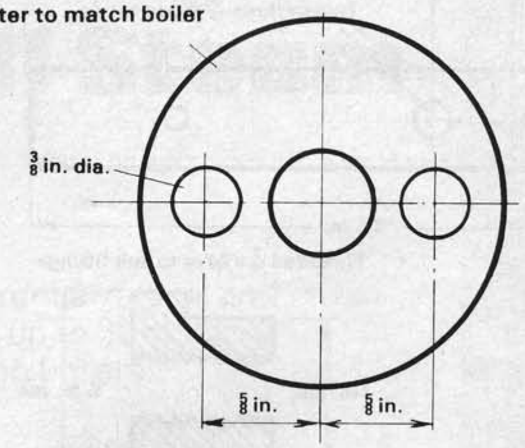
The ends of the boiler are two pieces of sheet. Ideally a wooden former should be made. The plates flanged over and turned down to a nice fit inside the tube before silver soldering. However, as the boiler is not going to work at high pressure there is no reason why they should not just be silver soldered to the ends with a lower melting point silver solder. Before fitting them, however, you must drill the holes for the bushes in the tube as this will release the air when you do the soldering. The tube can be squared off before the soldering by filing. Just lay a square along the top and file off the high spots until the whole thing is even.

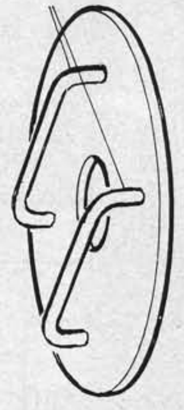
Once the ends are on the boiler then the holes must be drilled in them. In the top you will need two $\frac{3}{8}$ in. diameter for the bushes plus one in the centre for the chimney. The bottom will need four $\frac{1}{8}$ in. diameter for the water tubes and a central one for the chimney. The chimney itself is a piece of tube about ½ in. diameter. It has three tubes about $\frac{3}{16}$ in. diameter across the bottom of it and a hole at the top to take the exhaust tube. The tubes that go across are silver soldered in and again great care must be taken to ensure that the joints will not leak. Once they are fixed file them off flush and soft solder the water tubes and the chimney to the bottom of the boiler. The bushes that are required are available commercially or you can make them. If you do not have a lathe they can be filed down in a power drill. (I once knew a man who built a 5 in. gauge locomotive without a lathe and he made every part himself.) All five bushes can then be soft soldered in together with the top part of the chimney.

The two bushes in line on the side of the boiler are for try cocks. These can either be screws with holes in as shown or they can be little taps. Again they can be bought, but if you do buy them check that they match your threaded bush. The system is simple. The top cock is left open when filling the boiler. When water just drips out of it the boiler is full, don't try









Bottom of boiler showing water tubes

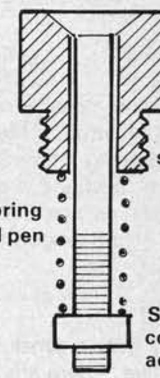
and put more in because there will not be room for the steam to expand. Once the boiler is in steam you test the level with the bottom one. If when it is opened the cock leaks water; O.K. if steam comes out then the water level is too low. The other bush on the side is for the pump. The two on the top are the steam take off and again this should if possible be fitted with a tap. The other one is for the safety valve. This should be adjusted when fitted and not tightened in any way. If you wish a further bush can be fitted on the top for a whistle. Instead of fitting the try cocks you may like to fit an electronic water gauge as suggested in Model Engineer, August 2nd, 1974. This instead of being used as a gauge can be used to switch an electric pump on and off and so keep the boiler level just right. The pump needs only to be the ordinary ram type with a connecting rod to an eccentric. The eccentric is turned round by the electric motor and this moves the ram up and down.

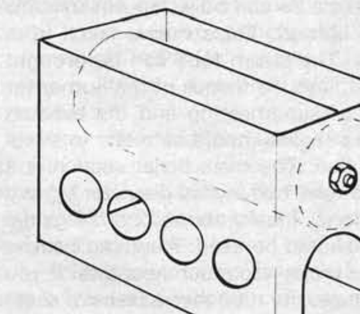
Whilst the boiler looks small it will supply ample steam it is supported on a tin plate frame as shown and this can be held on with a jubilee clip or screwed to the boiler with $\frac{1}{8} \times 40$ screws suitably filled with a jointing compound. Do not try to use any screws coarser than this as the boiler material is not thick enough to take it. It could also be soldered on with a bit of care. The tin plate used is again a bit of an old tin can and if the boiler is to go into a boat it should be soldered to a tin floor.

Burner

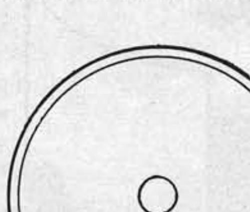
A three-wick evaporating type made up from copper tube. A couple of fins are soldered on to act as heat sinks. On the size given the burner will run about the same time as the boiler. So if an automatic pump is fitted you will need a larger tank for the fuel. The burner should be silver soldered where possible.

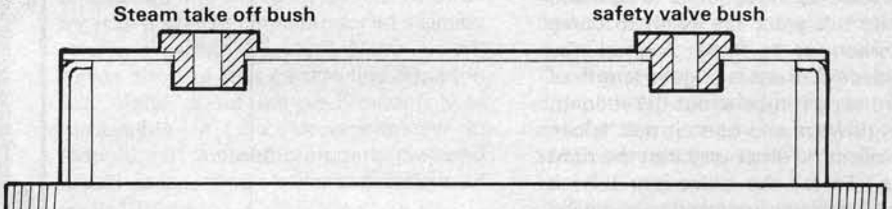
If we go back to the tin can boiler for a minute. It follows the same pattern as the boiler described with a chimney but no water tubes in the bottom. There is considerable danger of the seams giving out if you solder the chimney and bushes in and it can be done with epoxy resin providing the surfaces are well prepared. Ample time must be allowed for it to dry and it must cure under very slight heat. (Standing on a radiator is ideal.) However, it must be stressed once again that the tin can boiler is not suitable for pressures over about 10 p.s.i. and no attempt should be made to use it at a higher pressure. Far better any way to build the copper boiler described which has been tested to 200 p.s.i. by me and therefore is absolutely sound.





Horizontal boiler layout





A Small Part of Engineering History

by Andrew Smith

To be able to demonstrate, in a three-dimensional form, a brief period in the development of the steam engine, will appeal to many who are interested in technical pursuits. When the exhibits are reasonably accurate reproductions in miniature which actually work on steam, the demonstration becomes particularly real and meaningful.

A Real Vertical Steam Engine.

STUART TURNER LTD., of Henley-on-Thames have been known since the turn of the century for the excellent range of model—and not so small—steam engines which they supply as a very complete set of castings and all materials, screws, etc. For a number of their castings they have, for many years, been using the shell moulding process, a technique that produces castings of great accuracy and with an excellent surface finish.

This also means that the castings are done in cast iron, a metal that is true to prototype for this application. Beginners need have no qualms about machining this metal because Stuart Turner iron contains additives to ensure its free machining qualities.

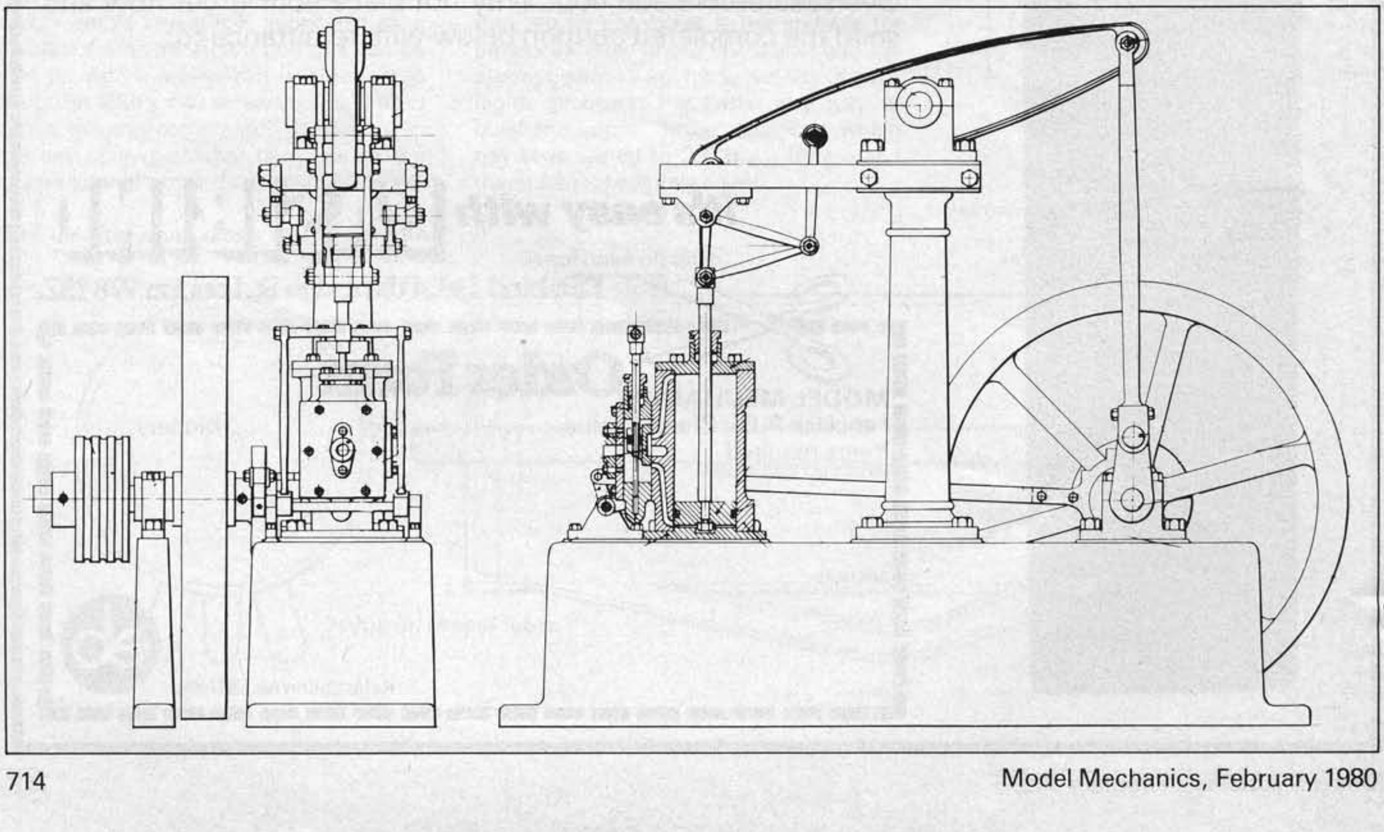
Some few years ago the writer was asked to prepare a constructional handbook dealing with the Stuart Turner Beam Engine introduced by Stuarts in the 1950s and historically the earliest type of engine in their range. As work on the engine progressed and an interest in these early examples of steam prime movers increased, one began to look at illustrations of such engines with a new feeling for the way they had developed. An understanding of the reasons for changes in configuration—for alterations in position of crank relative to cylinder—began to be appreciated.

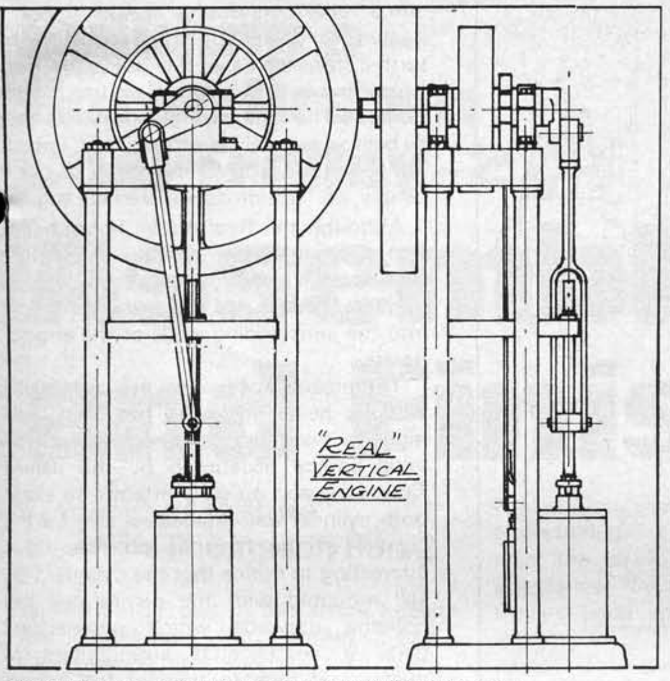
The decision to develop this appreciation further by actually drawing up and building a series of engines was taken when it was realised that many of the original engine builders apparently bought in such items as cylinders, flywheels, etc. These they incorporated into a design to suit their own ideas and the requirements of their customers.

The cylinder, complete with ports and passages cast in, produced by Stuart Turner Ltd. for the Beam Engine, together with the flywheel, so exactly suited the period that the decision was taken to develop a historical series of engines around these items 'buying them in', so to speak, just like the early builders of the real thing.

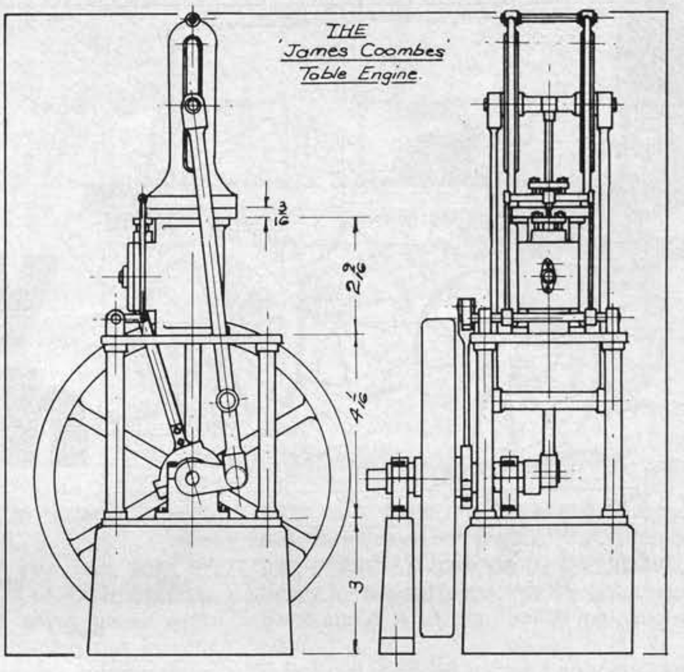
The beam engine appears to have been the earliest of such power sources and the first versions were, in effect, steam powered pumps with no thought or desire

General arrangement of the Beam Engine.





The Real Engine probably the easiest to build of the series.



Arrangement of the Table Engine.

for rotative motion. The cylinder was set where it should be, that is, on the floor, and the centrally pivoted beam was a convenient means of converting the piston stroke into a lift pump action.

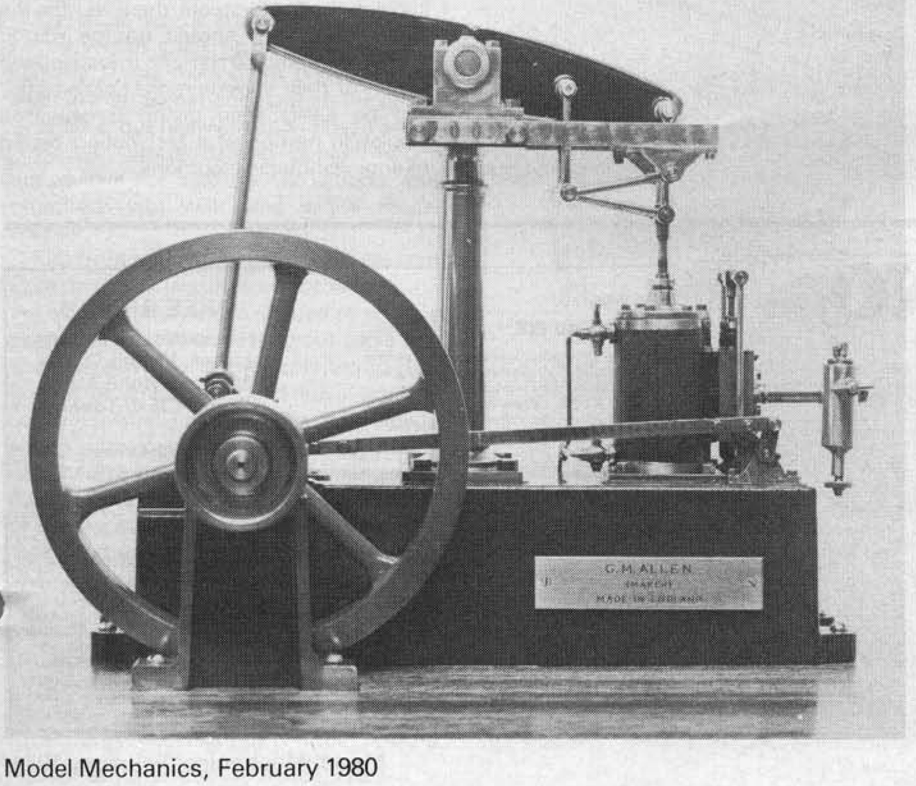
If I may digress, it may interest readers to know that only a year or so ago I was approached by a Missionary, who had also trained as an engineer, and was concerned with sinking village wells in remote parts of East Africa. He was interested in the idea of a small version of the 18th and 19th century non-rotative beam engine to pump water from these wells. Steam would be raised in a simple boiler fired with camel dung. (I had visions of having to beg some fuel from the local zoo in order to ascertain its calorific value!)

As the need for factory power appeared, the connecting rod at the end of the beam was coupled to a crank and shaft which produced a source of rotative power to drive the mills. The Stuart Beam Engine is based on this type. However, it was not long before it was realised that the enormously heavy (and expensive) beam was something of an anachronism.

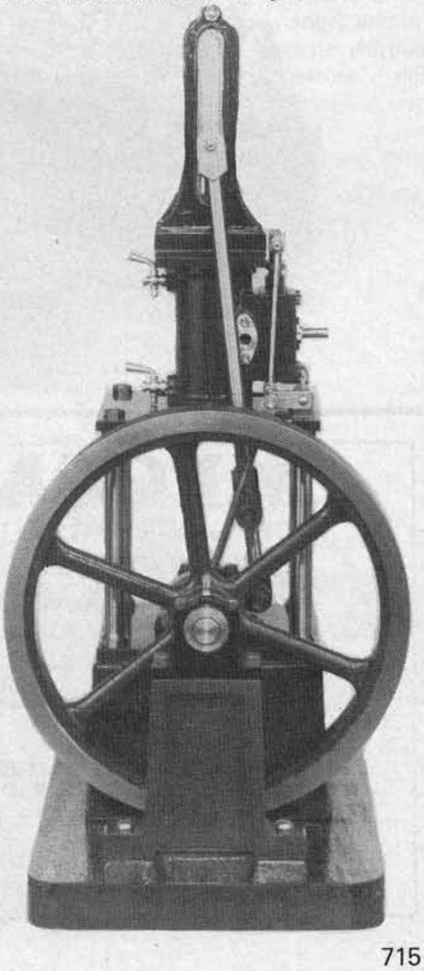
The beam was removed and the connecting rod attached directly to the end of the piston rod. The crankshaft and flywheel were then mounted on an entablature directly above the cylinder, which resulted in a smaller, lighter and cheaper engine and one which would run much faster now it was free of the sluggish inertia of the heavy beam.

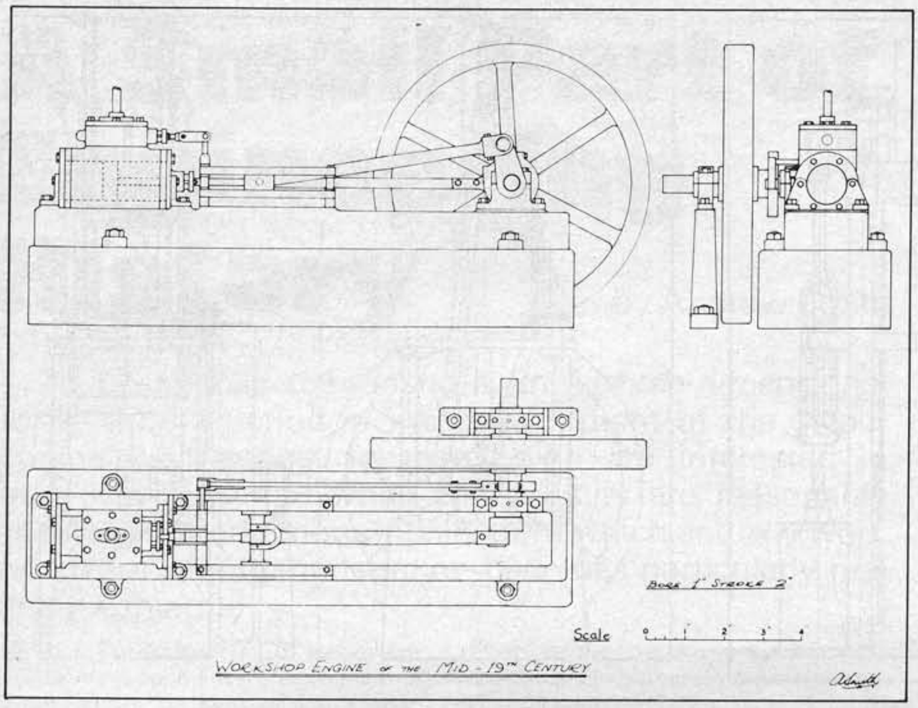
This scheme is followed in the Real vertical engine. It has often amused me when this engine has been called the Real engine, inferring that there may be

A beautifully built Beam Engine, the work of George Allen.



The James Coombes Table Engine.

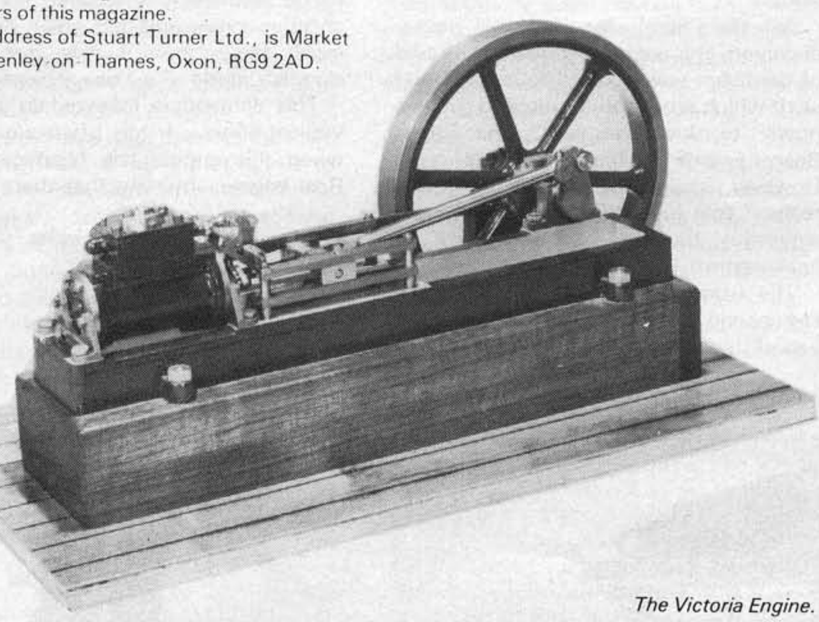




Victoria a 19th century factory engine.

The handbooks giving full details for the building of these engines are available from the publishers of this magazine.

The address of Stuart Turner Ltd., is Market Place, Henley-on-Thames, Oxon, RG9 2AD.



The Victoria Engine.

some regal connotation in the name! I hasten to say that nothing could be further from the case; it is called the Real because it is simply a 'real vertical steam engine'. The type we nowadays consider as being a vertical steam engine is, in fact, an "inverted vertical" engine or, to put it simply, an "upside down" vertical engine.

Although the Real model is built as a free-standing version with the entablature mounted on columns, these engines, in practice, usually had the entablature built into the surrounding walls of the engine-house.

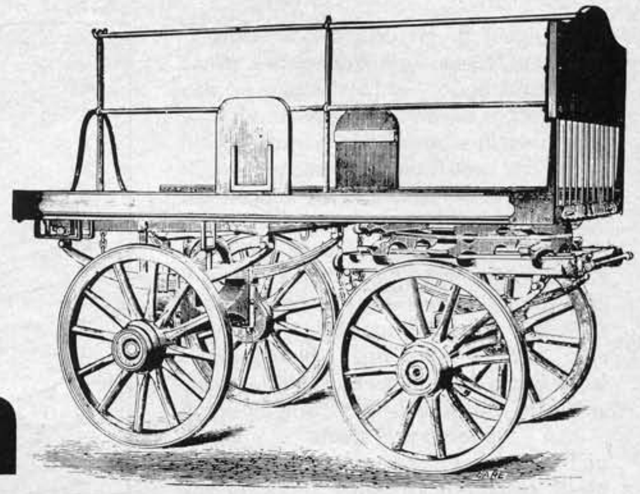
The problem of having the crankshaft, with its heavy flywheel, mounted fairly high up was soon appreciated and the table engine, illustrated by the James Coombes, was an early attempt to keep both cylinder and crankshaft as near the solidity of the floor as possible. It is interesting to notice that the cylinder was still mounted with the piston and rod pointing upwards which necessitated quite a complicated arrangement of guides and rods to transfer the motion from piston to crankshaft.

Eventually it was realised that the sensible and simplest configuration was to lay the engine down. In this manner, the weight of cylinder, guides, crankshaft and flywheel were all borne by the floor of the building. The model Victoria is a typical, factory driving, engine of this type.

Each one of these engines is fascinating and not difficult to build. Simple hand tools and a small lathe of 3½ in. centre height suffice. If your lathe is smaller or it skill is limited, Stuart Turner Ltd., will supply the cylinder and flywheel ready machined. The large box bed for the Beam engine is, in fact, normally supplied with its top surface already ground accurately flat.

These engines need only a small capacity boiler to steam them as, for the best effect, they should not be run at more than about 60 rpm. At this speed the action of their various rods, cranks, etc., can be easily seen giving a delightful display in motion of a fascinating period of engineering development.

Building a Horse Drawn Coal Trolley ~ 2



Assembly and Finish

A two-part feature by John Thompson Part 2

IN THE FIRST part of this article I dealt with making the trolley bed, undercarriage and shafts. These parts, together with the ready-made wheels, should all be painted black, and this is best done at this stage, before final assembly and the fitting of the rails and boards to the body.

I used Humbrol matt black enamel. On the floorboards the enamel was thinned with white spirit, and applied direct to the bare wood, to give an impression of the creosote finish on the original. On the other parts a wood grain filler or a full-bodied undercoat should be applied first, and rubbed down before the black is applied. If you get a good smooth surface then just one thinly-applied coat of the black will cover very well. A coat of clear varnish is needed to protect the soft matt paint — you could use matt or clear varnish accordingly to your preference.

The Nameboards

The small boards at the side of the body were used to chalk up the price of coal. Cut the shape from 3mm plywood, and paint in matt black. Then put on the prices — chalk is not really suitable, I used a little piece of "white carbon paper" which typists use for making corrections, but otherwise you will need white model enamel.

The front and centre boards are also cut from 3mm ply. As they are prominent on the model, great care is needed to achieve a good finish. When cutting out use a fine toothed saw to avoid splintering the underside, and if you still have trouble, sandwich the ply between two waste pieces while cutting. The edge of the ply will need to be well sealed and sanded to hide the end grain — you may need two or three coats of sealer or undercoat. I then used a Humbrol "Authentic" enamel in "Post Office" red, applying two coats. The lettering I used was a rub down type from "Miniature and Model Railways" of Rochdale. Being white with black shadowing it looks much more appropriate than the normal single colour lettering. As soon as this is done, apply a coat of gloss varnish, to protect the paint and lettering.

In the drawings you will see an alternative "livery". The Charrington's trollies used to be royal blue, with lettering in gold, and lining out in off-white. Only the wheels, which were treated with bitumen paint, and the creosoted floorboards were black.

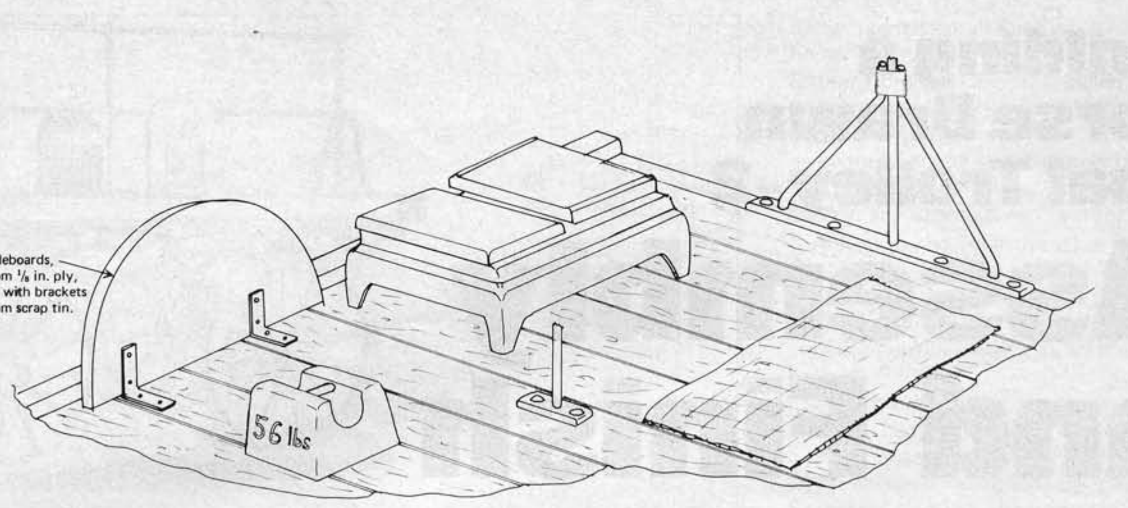
The posts to support the front-board are cut from ¼ in. square timber, and the lower parts have the edges fluted, for a decorative effect, before they are glued to the back of the frontboard. This assembly is glued in place just behind the front cross member of the floor frame, but do not fit it until all the work on the body is complete.

The Posts and Rails

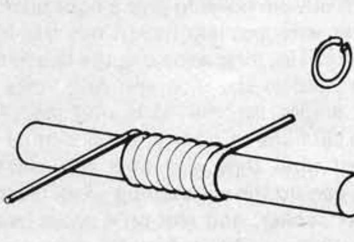
On an actual coal trolley the posts, rail and stays for this board would be made up from iron tube. I used a stiff wire coat-hanger to provide the rod, which was about $\frac{3}{32}$ in. dia. The joints between the upright posts and the horizontal rail posed a problem. A metalworker might turn them up to shape and drill sockets for the rod, but this is not feasible for a "table top" model. I solved this by using plastic beads for the rail joints; my daughter had some about ¼ in. dia., which look about right.

Drill out the holes to give a tight push fit on the wire you are using, cut the four uprights 4 in. long and push the beads on. Then hold in the vice and drill holes at right angles for the horizontal rail. The three sections of horizontal rail should be heated until they just melt the plastic. (You can do this on the ring of an electric or gas cooker, and test on a spare bead. On no account try to heat the wire on an electric fire element). Push the hot wires into the holes in the beads, cool with water, and you will find they are firmly bonded. Offer up the rail assembly to the centreboard, mark the positions of the uprights on the underside edge, and drill holes into the plywood, so that it will push onto the wire posts. To ensure a rigid assembly put a little epoxy resin in each hole.

The centreboard assembly is supported



by diagonal struts as shown in the sketch, also made from "coat-hanger" wire, which can be fixed to the upright by epoxy adhesive, with a strip of foil wrapped around the joint to make it neat.

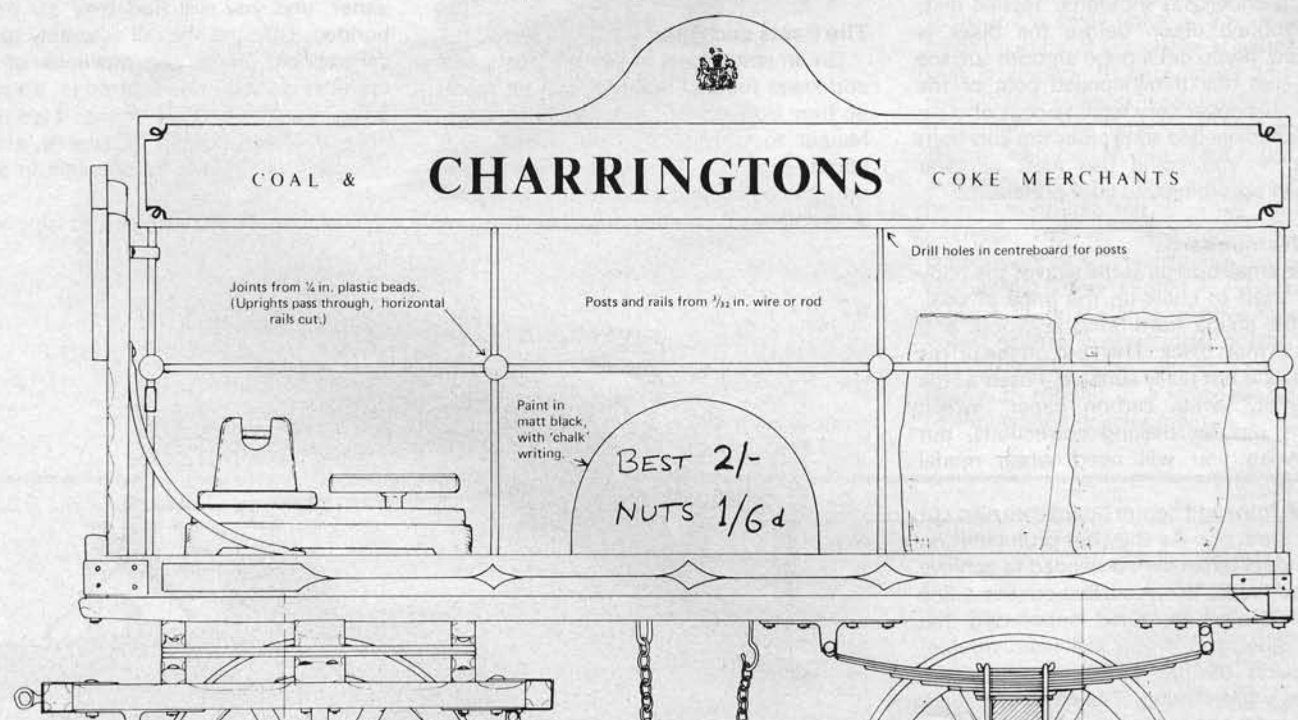


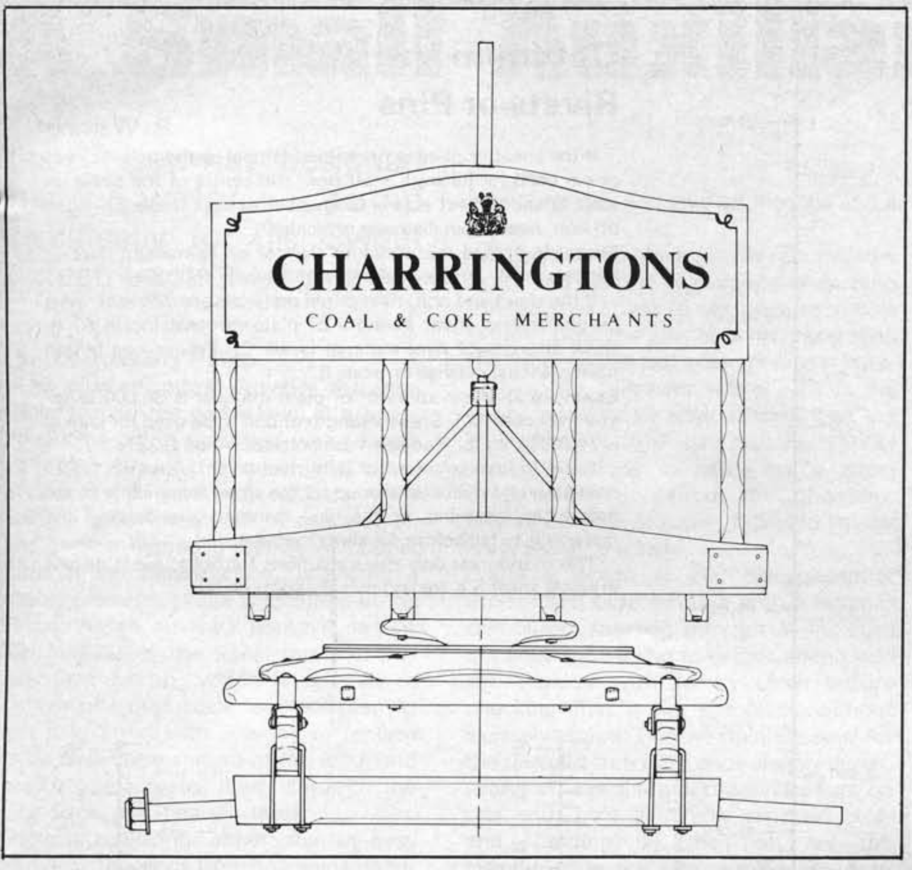
On the actual vehicle, the feet of the posts and struts would be welded to a strap, which would be bolted to the floor. Metalworkers might like to reproduce this, but alternatively a strip of wood can be glued to the floor to represent the strap, and holes drilled through it into the floor to take the ends of the wire. Once again, a drop of epoxy in each hole will keep the structure firm.

The Finishing Touches

Some coal trollies had a mechanical brake, but many relied on a tie chain, which hung on the nearside of the body, just in front of the rear wheel, and could be looped through the spokes of the wheel to lock it when on a steep hill. If you cannot find a suitable chain (about 8 links/inch) then it is not difficult to make one from wire, as shown in the sketch. The links are bent to butt together as the chain is assembled, and the gaps can be soldered if you wish, although on a "non-working" chain this does not matter too much as long as it is neatly made and painted.

The trolley should carry 40 sacks for a 2-ton load, with some full and others folded in a pile. I must admit my trolley is very lightly loaded, as needlework is not my forté! Use brown hessian, and brush in black shoe polish to give a well-used look.

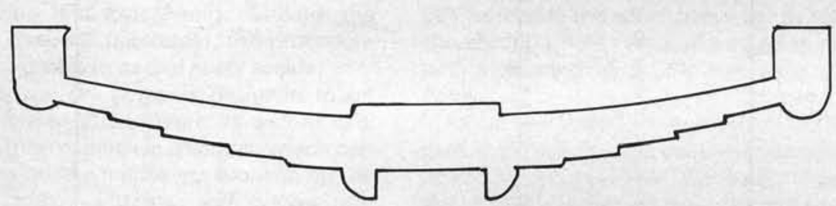




Other accessories could include the scales and weights. The base of the scales can be made from a "cough drop" tin, with the sides cut away so as to leave legs on the corners. Then add a piece of ply, slightly smaller than the base, and round off the joint with a plastic filler.

The lid of the tin can be cut in half to form the platforms for the scale, each mounted on a small wooden block. The sketch also shows the shape of the weights, which could be carved from wood blocks, with wire handles. The scales and weights should be a dull metal colour, and the Humbrol or Gloy "Gunmetal" shade is appropriate.

Finally, you may like to add a feed bag and bucket of water for the horse, these can be hung from hooks on the rear axle. People love to see these little gadgets and you will probably find a bucket attracts more attention than all your careful work on the springs!



An Alternative Simple Wooden Spring

Some people enjoy working with wood, but may be deterred by the metalwork on this model. Actually it is not difficult, but it is time consuming and "fiddly", so as an alternative I suggest modified wooden "springs", as shown in this full-size pattern. Cut them from ¼ in. plywood, and pin and glue direct to the body and the axle, and you can eliminate 90% of the metalwork of the model. They will not stand rough handling, but if well sanded and painted, they look quite effective.

The purist may object to such simplification, but I consider it is much better to make a neat job of something within your capabilities than to make a mess of a complex project.

The Art of Compromise

By I. Thwaites

Every practical hobby, of whatever kind it seems, is dogged by one thing—the equipment complex. As with all complexes it can be dangerous. If nothing else it can be very off-putting to the newcomer to the hobby. Allow me to explain.

This is how I define the equipment complex—the feeling that unless one has a particular item of equipment in a purpose-built workshop then certain projects cannot be undertaken. For example, the modeller comes to feel that unless he has a pillar drill or a Unimat then he will not be able to produce a certain model. The result is that he does not even attempt to build it, but carries on with what he has been doing. He loses the will to move on to anything new, does not move outside his own well-trodden field and can even lose interest in the hobby as a whole. A negative attitude creeps in. How many times, for instance, do you hear somebody say, "Oh no, I cannot build that because I do not have a . . .?"

Fine models can be made with a vast range of tools in the most elaborately equipped workshop but equally fine models can be made with simple tools in equally simple surroundings.

The whole matter of equipment and the quality of the work produced needs to be carefully balanced. many new modellers would be very surprised to find just how many excellent models have been built using hand tools on a kitchen table, these models appear to have come from a complex workshop simply because the standard of workmanship is so high. On the other hand there are fine models which have indeed come from equally fine workshops. The whole thing really is a question of balance but one thing above all else should be remembered—it is the workman and not his tools which ultimately is responsible for a fine model.

My own feelings are simply explained. Whatever tool one has must be of very high quality, no matter whether it be a basic hand tool or something complex and powered. It is no good at all buying a cheap tool as it will not last, nor perform correctly. Your motto should be to buy the best, even if it is only a simple screwdriver. Personally I would rather go without a tool rather than buy an inferior one.

Optimum size of Bolts, Rivets or Pins

R. Warring

If the sheet or plate is the *same* material as the bolt (or rivet or pin used for joining), start from the centre of the circle on scale B and project across to sheet thickness (scale E). Read off bolt, rivet or pin diameter on scale D.

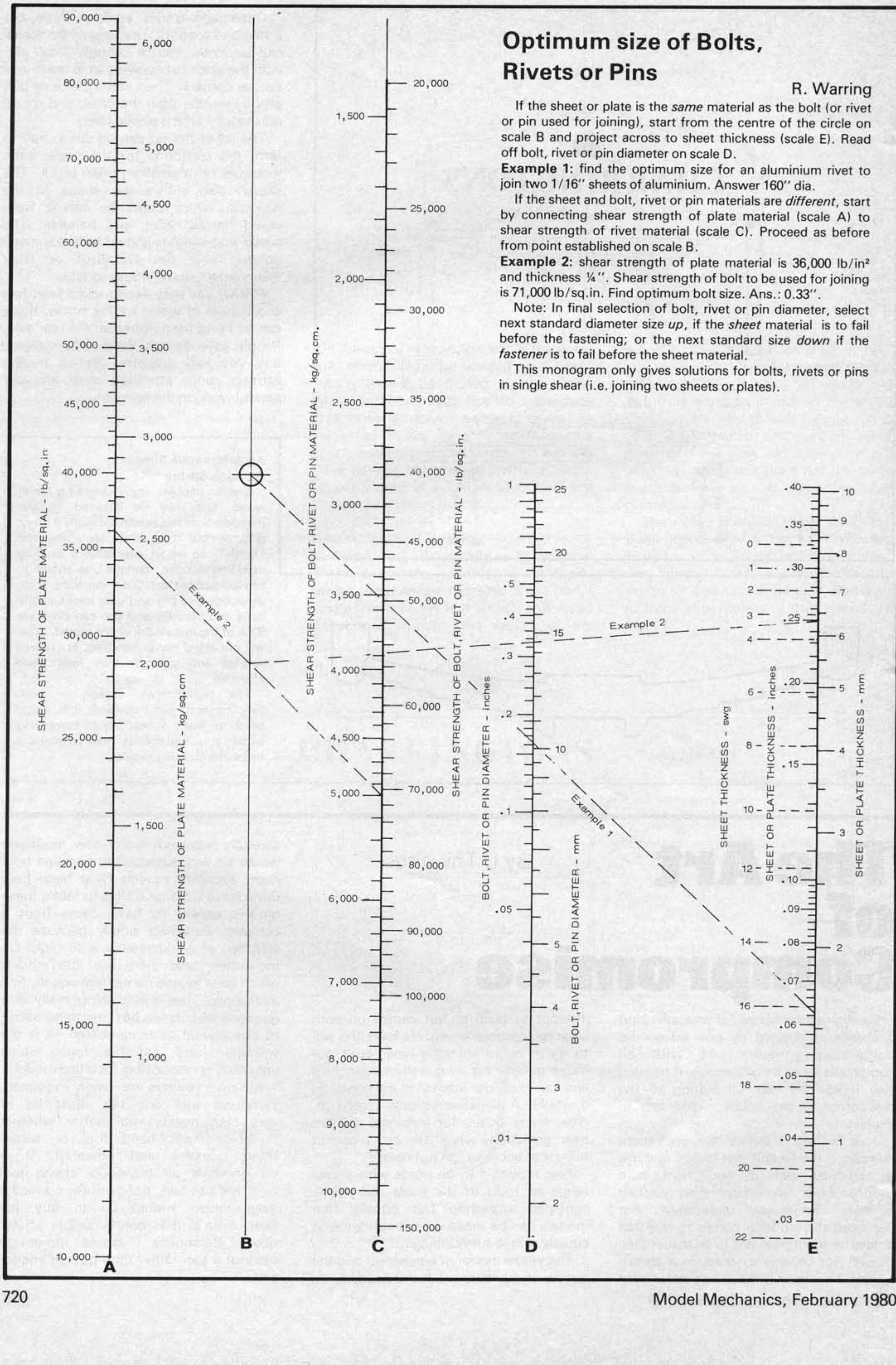
Example 1: find the optimum size for an aluminium rivet to join two 1/16" sheets of aluminium. Answer 160" dia.

If the sheet and bolt, rivet or pin materials are *different*, start by connecting shear strength of plate material (scale A) to shear strength of rivet material (scale C). Proceed as before from point established on scale B.

Example 2: shear strength of plate material is 36,000 lb/in² and thickness ¼". Shear strength of bolt to be used for joining is 71,000 lb/sq.in. Find optimum bolt size. Ans.: 0.33".

Note: In final selection of bolt, rivet or pin diameter, select next standard diameter size *up*, if the *sheet* material is to fail before the fastening; or the next standard size *down* if the *fastener* is to fail before the sheet material.

This monogram only gives solutions for bolts, rivets or pins in single shear (i.e. joining two sheets or plates).



A Small Auxiliary Pump

Rex Tingey has designed this water pump specifically for his Sweet Sixteen traction engine

A Small Auxiliary Pump

This auxiliary pump provides a means of maintaining the water level in a boiler without the aid of the fitted water pump in a locomotive or traction engine, often necessary when getting up steam or when testing a boiler on steam. It can also be used for the hydraulic testing of copper boilers under construction, providing a suitable pressure gauge is included in the system. As an auxiliary pump it can be used instead of the usual pump-in-the-water-tank set-up, which is difficult to contrive on small scale locomotives. As such it is fitted with a lance to replace the by-pass valve spindle of the loco, and thus to pump water direct through the boiler clack, and maintain level.

Before removing either the by-pass spindle, or the lance from an engine under steam, loosen and check that no steam is passing to the water tank before fully removing by unscrewing. Should the boiler clack ball fail to seat, this procedure will avoid accidents and nasty scalds.

The auxiliary pump is designed to be made easily and to work as well as one made from expensive castings, which can present quite a machining problem on the small lathe. Fittings and valves are inserted as separate into a main duralumin block, and all the components are made on the Unimat lathe. The capacity of the pump is ¼ in. bore × $\frac{9}{16}$ in. stroke. The pump is connected to a water reservoir in the form of a 1 litre jerrican, by means of silicone rubber tubing to carry the water to the inlet valve of the pump, and whilst the tubing is capable of withstanding considerable pressure it tends to fly off of unions under pressure unless secured with some sort of hose clip. To eliminate the need for hose clips, in this small size, nylon tubing is used for the pressure side between the pump and the by-pass valve. The nylon tube used has an internal diameter of 6mm, which taps ¼ in. × 40, into which brass fittings can be screwed and sealed with Loctite. The lance to fit into the by-pass body is made to swivel in a block for ease of fitting.

The Pump Block

The pump block is made from 1in. square duralumin stock. Cut a piece just over $1\frac{5}{8}$ in. long and mark out diagonals on each end to centre punch. Fit into the four-jaw chuck and centre up to square off each end with a knife tool, down to the exact length, as close to the centre as possible. Drill one end for the securing screw, No. 22, and take off the pipe at the other.

Mark out the block for the ram cylinder bore, and for the two valves. Adjusting the four-jaw chuck to centralise each hole in turn, bore the $\frac{3}{8}$ in. hole first, and then the other two to just enter this main bore, tapping the holes for valves 2BA in the lathe, immediately after drilling. Tap the block securing hole right into the cylinder bore: this hole is used for a short grub screw to secure the phosphor bronze cylinder in place, followed by the main securing screw.

Cut a length of $\frac{3}{8}$ in. dia. phosphor bronze and bore through with a letter D drill before reaming through ¼ in. Turn the ends square and to length, then clean the outside with emery cloth before checking that it fits the block without excessive force. Cut the stainless steel for the ram and turn both ends cleanly down, taking off the sharp corners. File flats on one end, hold in a soft clamped vice, and, holding by the flat, try the cylinder onto the ram, easing any tight spots with a little Brasso; clean off well. Loctite the cylinder into the block with 601, screwing the short screw tightly into the securing hole. When cured clean off with a cleaning spray, oil, and re-tap the holes.

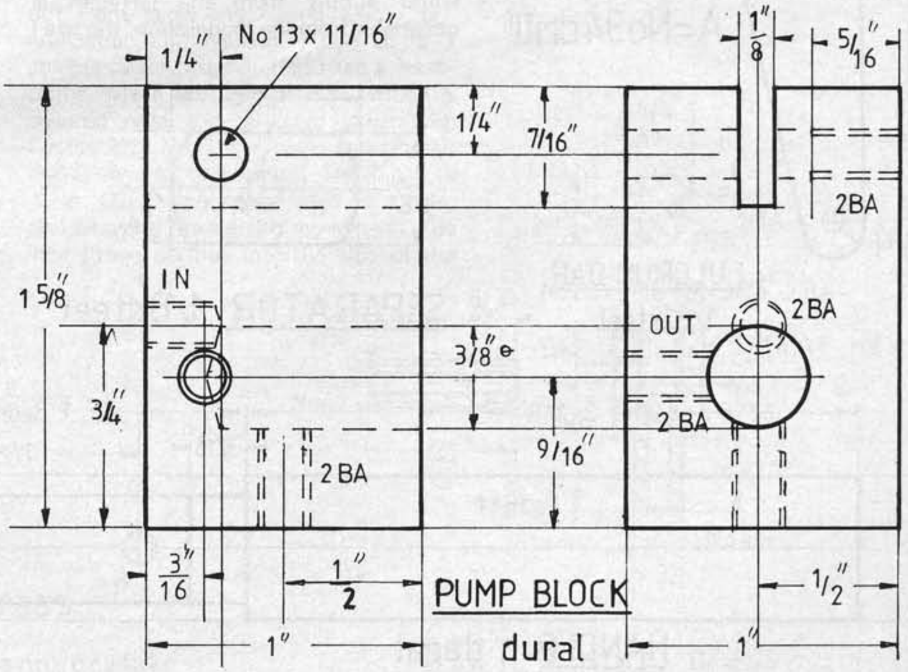
Fit up the Unimat in the vertical mode with the machine vice on the cross-slide and a $\frac{1}{8}$ in. end mill in the drill chuck, to cut the slot for the fulcrum bar. Cut the near wall from left to right and the far wall the opposite way, with a four division adjustment of the cross-slide handwheel in between. This will give a slot with sufficient clearance, but if the fit of the bar is a little slack just fit a 4BA brass screw at an upper front corner to bear against the bar and take up any slack. Drill the hole right through No. 22, and then the first 11/16 in. No. 13 and tap through 2BA. For the bar pivot use a 1 in. bolt with about $\frac{5}{8}$ in. unthreaded shank.

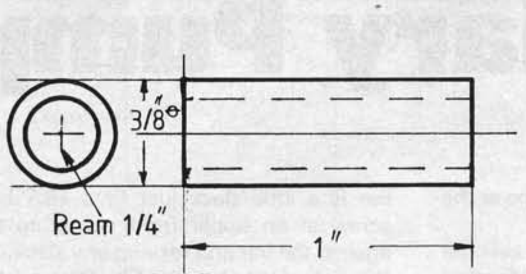
Drill the hole in the ram end-flat, cut out the $\frac{3}{32}$ in. and $\frac{1}{9}$ in. mild steel flats a little oversize. Drill just one hole in each of the two lever sides and secure them together before drilling the other holes and filing to shape. Cut a length of dural for the handle and drill the two holes before returning the Unimat to its lathe form for turning the handle down, and then filing the flats. To secure the parts of the lever use ½ in. hex. head 6BA bolts with ¼ in. of the shank unthreaded. When all the nuts are tightened cut off the surplus thread and file smooth.

Turn the O-ring cap from light alloy hexagon stock, drilling through ¼ in. and counterdrilling $\frac{3}{8}$ in. Fit the O-ring before Loctiting with 222, ram in place and oiled, and with the cap not quite pushed fully home. If the O-ring ever needs changing the cap can be wrenched off quite easily.

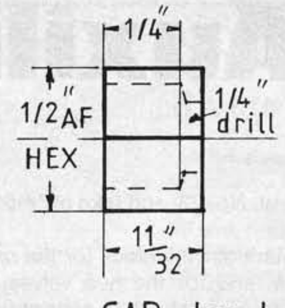
Water Valves

The non-return valves are turned from hex. brass stock. The inlet valve body is made first; turned, drilled and counter-drilled No. 22 and then tapped 2BA for the cap. Make a spot for the outlet on one face of the hex. and secure in the four-jaw chuck, two jaws reversed, to drill and tap 2BA. Make the cap and outlet tube from hex. brass and Loctite 601, keeping it from protruding into the body far enough to interfere with the ball action. Fit a $\frac{1}{8}$ in.

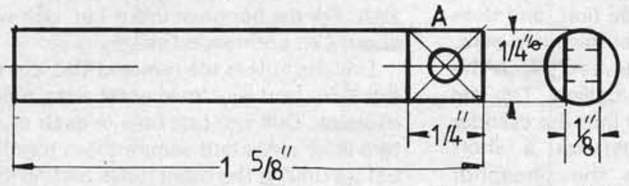




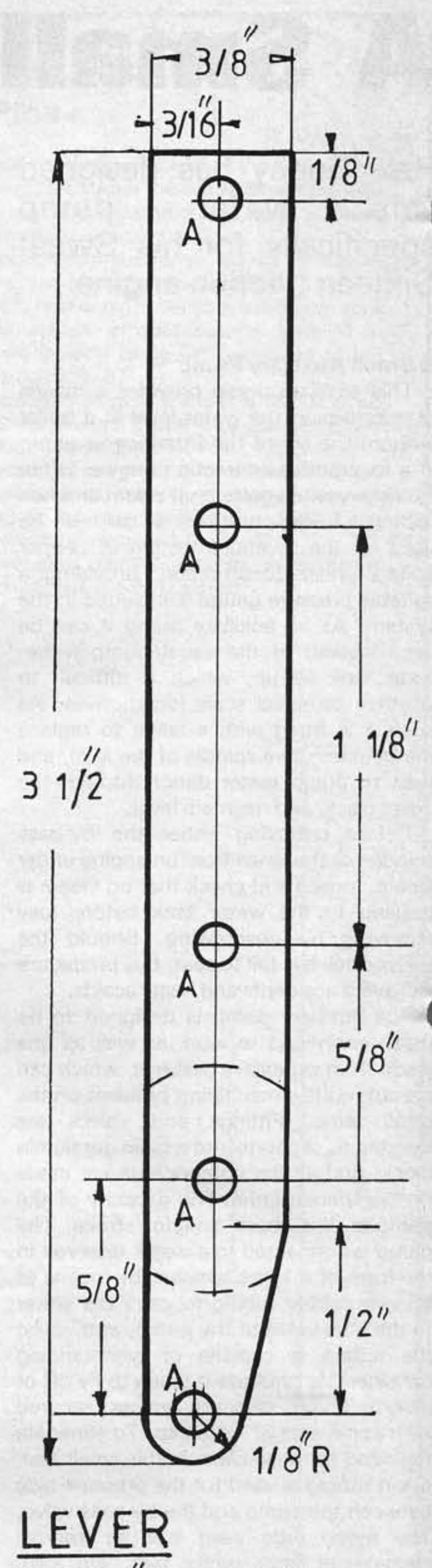
CYLINDER ph. br.



CAP dural



RAM st. st.



LEVER
3/32"steel 2 off

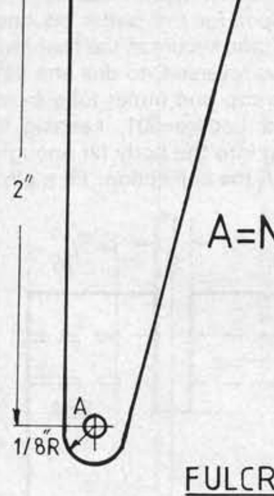
steel ball, a piece of brass rod, and place the inlet tube loosely in the vice, body resting on its jaws, to give the rod a good tap with a hammer. Remove the ball and replace it with a phosphor bronze ball of the same diameter, checking the seat with a blow and a suck. If all is well, fit the cap to allow the ball about $\frac{1}{20}$ in. movement, the equivalent of 1½ turns of 2BA thread.

The outlet ball valve is lightly spring loaded to provide a more positive seating in the horizontal position. This valve is in line, and no side fittings are required. The ball is $\frac{5}{32}$ in. dia. to provide more room for the spring. The spring is a $\frac{1}{8}$ in. ID stainless safety valve spring, 24 WG, from Messrs. Reeves, and 3½ to 4 turns are used, the ends being lightly ground to flats on a fine grinding wheel. The outlet is first screwed into the body until the ball just stops rattling, the end thread is touched with Loctite 222, to surround it, and a further quarter of a turn applied to tension the spring. Oil into the hole to prevent migration of the adhesive.

Secure the cleaned off valves into the pump body, using 222. Assemble the lever action and mount the pump onto a piece of ¼ in. duralumin flatstock, or other suitable material, to give a good bed. Use a 2 BA countersunk screw through the base into the body, also adhering the body to the base with a Loctite. Oil the working parts well.

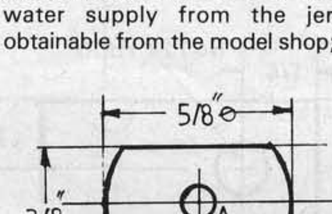
Other Fittings

Make the jerrycan outlet from brass, securing it into a hole drilled in the base of the plastic reservoir with cyanoacrylate adhesive, pressing the fitting well home with a piece of thick rag, and then flushing with water to ensure that no free adhesive survives to stick unwary fingers. Remember to drill a small hole in the lid of the jerrycan! The silicone tube for the water supply from the jerrycan is obtainable from the model shop; the size I

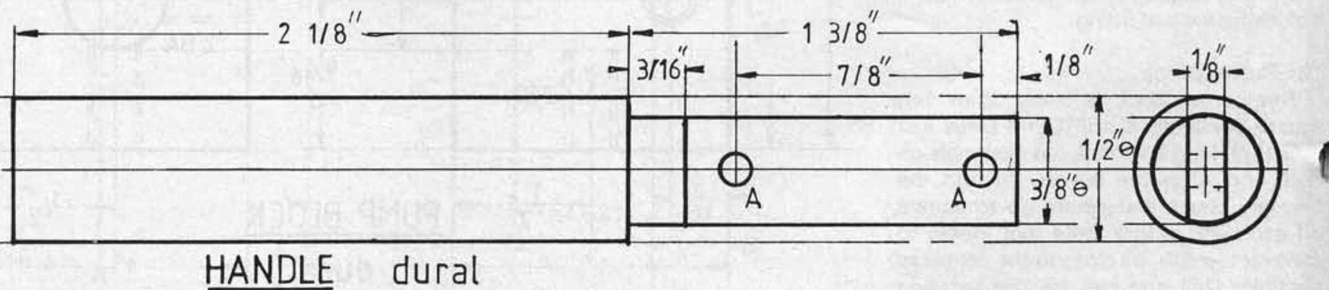


A=No34drill

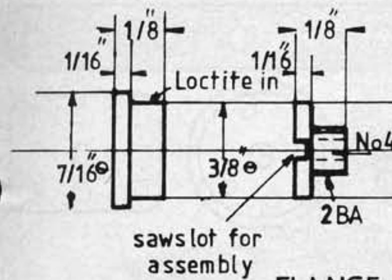
FULCRUM BAR
1/8"steel



SEPARATOR 1/8"steel

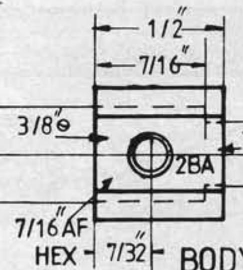


HANDLE dural

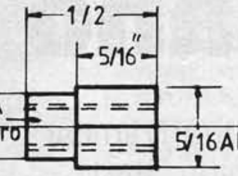


CAP brass

FLANGE brass



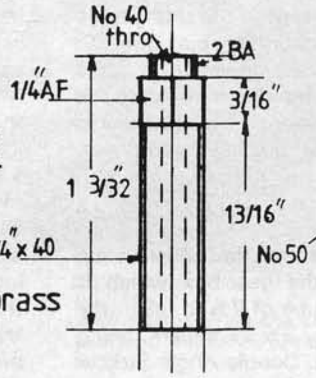
BODY brass



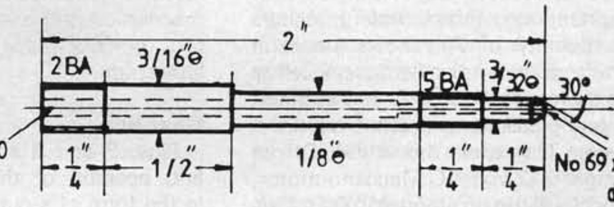
SWIVEL brass

BY-PASS ADAPTOR

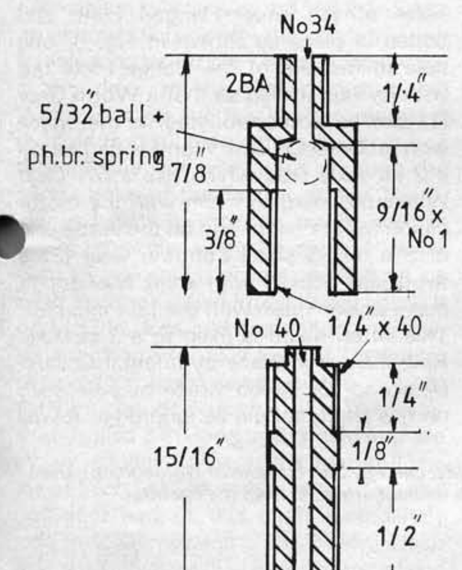
fit 1/4" ID O ring



INLET brass



LANCE st. st. (for Sweet Sixteen)



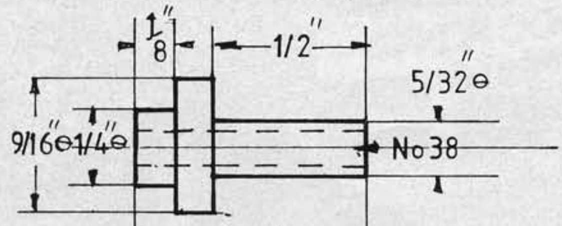
OUTLET VALVE brass

used is 6mm OD, and 2.5mm ID. Fit the tubing, fill the jerrycan with water and give the pump a good test.

The pump, as it stands, can be used for all sorts of jobs which crop up, even the hydraulic testing of boilers up to high pressure, but copper tubing and proper water unions will have to be fitted, and a good-sized pressure gauge built into the system. Just as an auxiliary pump a device to replace the by-pass valve spindle will have to be made. Make the lance first, turning down the steps on one end, and threading each end in the lathe, before drilling through and making the taper. Use plenty of RTD or similar compound when threading the stainless steel, and start with the die well open. The drilling through will need to be carried out from each end, using plenty of lubrication and cooling; I use 20 to 1 soluble oil for this, squirted from a wash-bottle. Make the brass swivel, which is secured onto the threaded lance with Loctite 222. This fits into the brass body, and is secured to turn with the flange, a ¼ in. OD O-ring being fitted as a seal, also allowing the turning movement. The inlet fitting secures into the side of the body, 2BA, so that it does not impede the swivel movement or the securing of the cap, both the inlet and the cap being secured with Loctite 601. The inlet is threaded at its other end ¼ in. × 40 for the nylon tube, and the flange has a screwdriver slot to ensure a good tightening down, without the need for sealing.

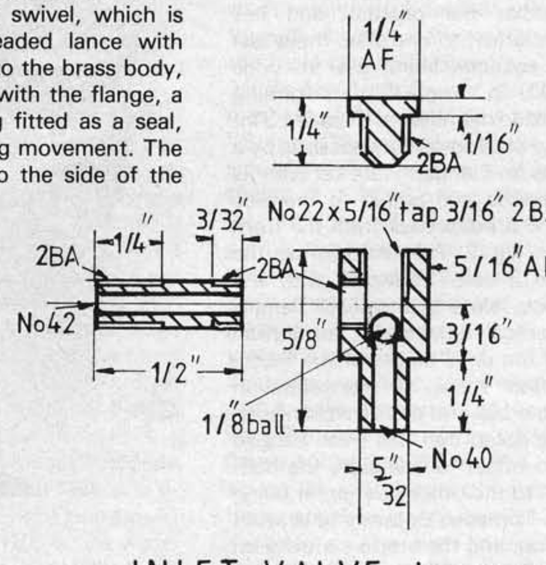
In use the tube should be full of water before the lance is inserted into the by-pass body. Further pump action will then produce immediate pressure to enter the clack against steam pressure, also sealing back the engine's own pump valve.

Various lances can be made to fit differing by-pass valve sizes. For high pressure applications it may be necessary to clamp the nylon hard onto the fittings, for safety.



RESERVOIR OUTLET brass

secure with cyanoacrylate



INLET VALVE brass

Meccano

By Bert Love
Automated "O" gauge Tramcar with Self-programming Start, Sequences

Mention of "Programmed" mechanisms these days tends to conjure up visions of micro-chip electronics, but mechanical automation goes back to clockwork and its origins in ancient Chinese history. Jim Gamble of Nottingham, one of the founder members of the Society of Advanced Meccano Constructors, is an excellent modeller as well as a Meccano historian and archivist and it is a pleasure to present his novel "O" gauge Tramcar in this article. Driven by a single 6-12 volt DC Meccano motor, this model will run on standard "O" gauge tinplate track with overhead insulated pick-up trolley and will repeat a sequence of bell-ringing signals coupled with the start and stop movements of the tramcar. Bodywork of the tram is deliberately kept simple as the accent is on what is inside in the form of automated mechanism. Readers who are looking for more ornate finishes are recommended to refer to the author's book "Model Building in Meccano and Allied Constructional Sets. Construction is not difficult or complicated but Figs. 2 and 3 must be studied carefully. It will be noted that a pair of Meccano Boiler ends are mounted above the chassis and these are the actual bells which give a very realistic "ding-ding" as the car moves off and for the purposes of this article, the bell end of the chassis will be referred to as the 'front' of the vehicle.

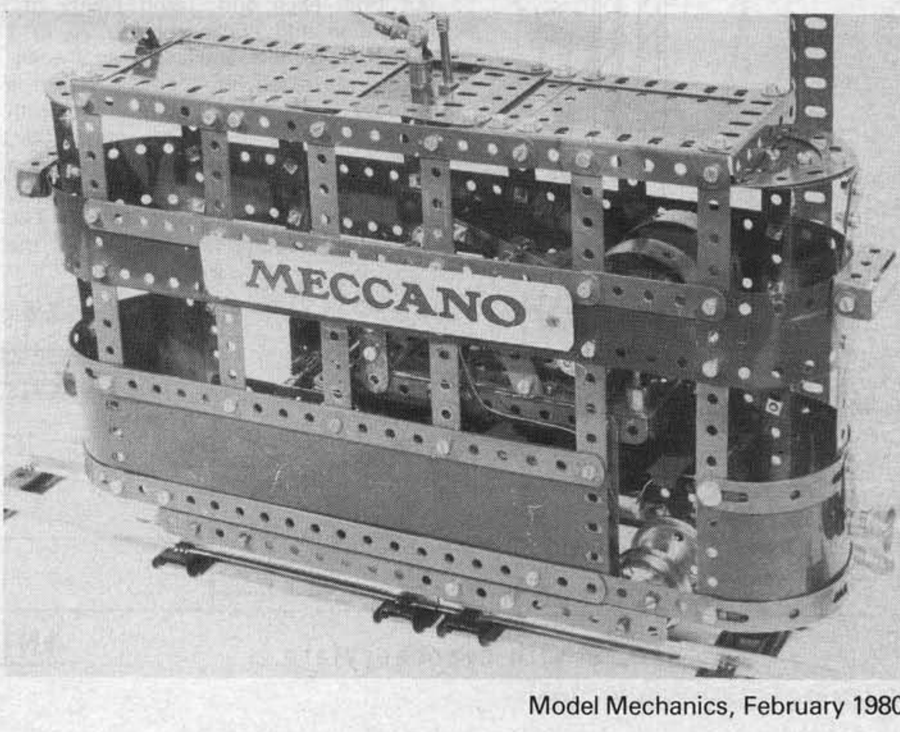
Chassis

This is of open-ended constructon to permit good clearance of the flanged wheels and their driving gears and it will be noted that the gearbox and bell platform are offset to one side, these last mentioned sections being 2½ in. wide while the 9½ in. Angle Girders forming the chassis side members are spaced 3 in. apart. Cross-bracing of the chassis is by a 2½ in. × 1½ in. Flanged Plate set with its flanges upwards and bolted to the side girders 6 and 8 holes back from the front as shown in Fig. 2. This plate carries the Meccano 6-12 volt DC Motor with six-ratio gearbox, slots in the plate flanges allowing vertical adjustment for critical meshing of the drive pinion of the motor with the first stage of the reduction gearing to the bell and drive mechanisms. It should be noted that this small flanged plate is also offset to one side, the half-inch 'reach' to the other side girder being taken up by Threaded Bosses and Washer packing. Mounting the motor centrally on the Flanged Plate will bring it into correct position but final alignment should be made at a later stage when setting up the gearbox. At each corner of the chassis, a Rod Socket is screwed to the side girders to act as an anchoring point for the Tramcar body, thus providing a rapid method of removing the tram body for mechanical adjustments by unscrewing four bolts without fiddling inside with loose nuts.

Gear-box

Figs. 2 and 3 show the construction and position of the gear-box which is in the form of a cube of 2½ in. side, the vertical side plates, 2½ in. square, being spaced by a 2½ in. Double Angle Strip at the open end of the box, set one hole up each side. A 2½ in. × 1½ in. Flanged Plate braces the forward end of the gear-box and this can be seen in fig. 3. It should be noted that this plate has a slightly shorter span than a 2½ in. D:A. Strip so a packing washer is placed between the side plates and the Flanged Plate on each of the four attaching Bolts. Location of this small Flanged Plate is central, i.e. one hole in, or up, from either end of the 2½ in. Flat Plates. Two more 2½ in. D.A. Strips are set inside the gear-box to act as journals and these can be seen in Fig. 3. One of them runs from front to back, being attached to the small Flanged Plate at the front and to the outside cross member (the first of the 2½ in. D.A. Strips) at the rear. Washer packing is critical at this stage and should be noted as follows. At the right-hand side of the rear 2½ in. D.A. Strip, it securing Bolt must be padded with a washer, outboard, so that only the nut thickness appears inside the gear-box. This is to give maximum displacement of a sliding Gear Wheel in the "start/stop" mechanism. The internal 21½ in. D.A. Strip, running front to back, must also be set up with a packing washer on its bent lug so that an Axle Rod passed through the gear-box side plates will pass cleanly through the internal D.A: Strip without binding. This then ensures correct alignment. A second internal D.A. Strip is set across the gear-box, level with the top holes of the small Flanged Plate and bolted in place as shown in Fig. 3, one hole to the rear of the Flange Plate but with its lugs turned so that a Worm Gear (1) can be accommodated in the space without binding. This Worm is carried on a 2 in. Axle Rod which has a 57t Gear Wheel outboard to mesh with the motor pinion (a 25t Pinion) and on the inside end of this rod, a small Contrate Gear (2) is fixed and packed with shim washers to make a clean mesh with the 19t Pinion (3). This latter Pinion is fixed to a 3 in. Axle Rod and set in place by internal Collars. (A scond 19t Pinion which may be seen on this shaft, should be ignored as it was

Fig. 1 *Self-programming "ding ding" Tramcar in Meccano by Jim Gamble of Nottingham. Tram responds automatically to stop and start bell signals without attention from the operator.*



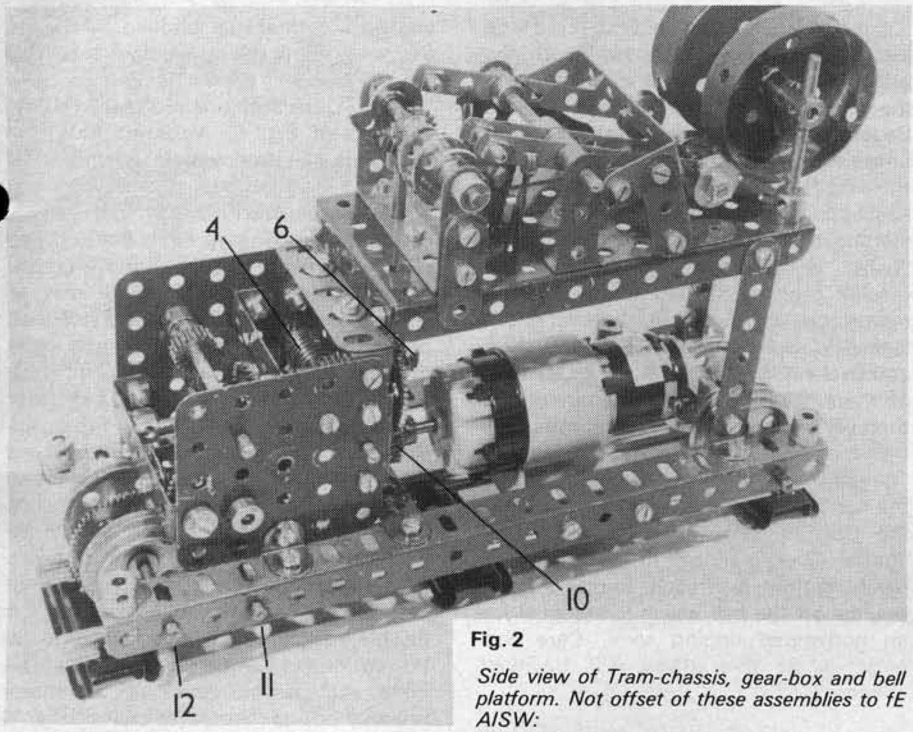


Fig. 2

Side view of Tram-chassis, gear-box and bell platform. Not offset of these assemblies to fE AISW:

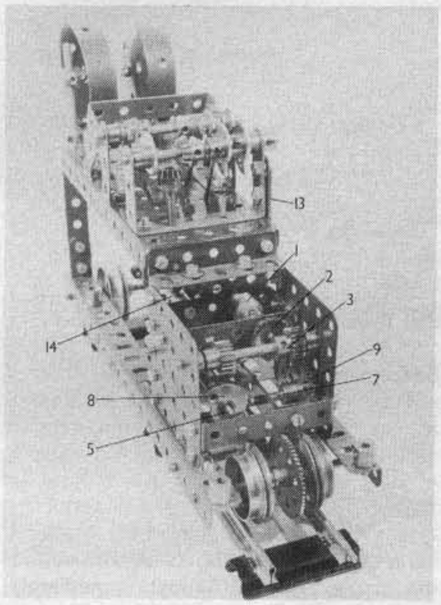


Fig. 3

General view of cam-operated gerar-box from which motion of the Tram and the two distinct bell signals are automatically controlled.

originally intended for an additional mechanism which was not used and has no connection with the construction outlined in this article.) Hidden from view is the drive to the first cam-shaft off Worm Gear (1) and this shaft is another 3 in. Axle Rod running across the gear-box through the side plates and through the centre holes of the flanges on the 2½ in. Flanged Plate.Its location can be seen in Fig. 2, together with the second Worm Gear (4). Worm (1) passes on its drive via a 19t Pinion (hidden) immediately below it on the 3 in. Rod just mentioned and then via the Worm (4) to a second 19t Pinion (also hidden from view) which is fixed to the fore and aft cam-shaft (5). This cam-shaft is also 3 in. long and is held in place by an inboard Collar at the rear and the 19t Pinion at its other end. On the outboard end of this shaft (completely hidden from view) is a 25t Pinion which will engage with a 25t small Contrate Gear (6) which can just be seen in Fig. 2. More details of this will be given later. The last shaft to be fitted in the gear-box is the 1½ + in. Rod (7) which is actuated by the Meccano Cam (8), Part No. 131. This cam must be carefully aligned with its blade edge to the axis of the 1½ in. Rod. One half of a Meccano Compression Spring is cut to be placed behind the face of the 57t Gear (9) holding the gear in mesh with its overhead Pinion (3) until it is actually pushed out of mesh by the cam action.

At this stage the gear-box should be tested, as a separate item, for smooth meshing and shaft clearance, setting up running washers for smooth action and no binding. The cut length of Compression Spring should allow engagement of the 57t Gear (9) for about ⅔ of the rotation of Cam (8) before the cam actually begins to push Rod (7). A final adjustment will be required later to synchronise this action with the bell strike. If all is running well, the gear-box may be mounted on the chassis as follows. Fix a 3 in. Strip across the chassis side members on top of the girders, 8 holes along from the rear to give added bracing. To the left-hand side plate of the gear box, bolt ½ in. Brackets at each end, at the bottom, by their slotted lugs, plain hole lugs pointing inwards. Fix one more ½ in. Bracket to the other side-plate, at the bottom, centrally as shown in Fig. 2. This then gives a three-point fixing for the gear-box, in the off-set position clearly seen in Figs. 2 and 3. Fit the Meccano 6-12 volt DC Motor with 12 ratio gear-box in place with a 25t Pinion (10) on its shaft, setting the motor in the 16:1 ratio for a trial "dry" run. At this stage, all gearing listed so far should run sweetly and Cam (8) should push shaft (7) to one side with a clean action followed by a definite "snap" action of the shaft springing back into mesh. Two more 3 in. Axle Rods are needed for the drive to the Tram wheels located at positions (11) and (12) in Fig. 2, each road being held in place by internal Collars with Washers for smooth running. Shaft (11) carries two 19t Pinions, one being set to pick up the spring-loaded Gear (9) and the other to drive the dinal 57t Gear on the back axle of the Tram. If another pair of large Flanged wheels are fitted to the front of the chassis, the travelling may be tested on a straight length of 'O' gauge tinplate track by "earthing" one motor connection to the chassis framework, one wire from a 6-12 volt DC supply to the track and a single flexible lead to the other motor terminal from the supply source. This should result in a definite "run/stop" sequence.

Bell platform

All components for the bell platform are mounted on a 5½ in. × 2½ in. Flanged Plate and may be assembled as follows, Figs. 2 and 3 being carefully studied at the same time. At the front corners, Rod Sockets hold 2 in. Axle Road vertically at each side, the Rods carrying Threaded Couplings pointing inwards for mounting the meccano Boiler Ends, acting as the bells, at a later stage of construction. A pair of Flanged Brackets, one right-hand and one left-hand (Part Nos. 139, 139a) are next mounted in the positions shown in Fig. 2. Acting as hammer stops, is a 2½ in. × 1 in. Double Angel Strip which straddles over the top of the Flanged Brackets and is locked in place, to the arms of these Brackets by a 1½ in. Strip on the side in view (see Fig. 2). Finally, a 2½ in. × 1½ in. D.A. Strip is bolted across the bell platform, one hole in from the rear to act as the journals for the triple-cam-shaft which operates the bell signals. it is important that the second hole from the left on this D.A. Strip gives perfect clearance for the vertical drive shaft coming up from below, as it passes through the bell platform. Bevel drive to the triple-cam-shaft imparts a side-thrust which can be sufficient to displace the meshing of the bevels so a pair of 1½ in. "Strips" (13) are locked to the right-hand side of the D.A. Strip to take up this side-thrust. If 2 in. Slotted Strips are used instead, they will give sufficient reach to permit their lower (slotted) ends to be bolted to the large Flanged Plate edge. Note that the front end of the bell platform is attached to the chassis by vertical 3 in. Strips and ½ in. Brackets in the staggered positions shown in Figs. 2 and 3. Rear attachment of the platform is via a 2½ in. Angle Girder with its slotted flange bolted to a 2½ in. D.A. Strip fixed across the top of the main gear-box at its front. Location of the vertical 3 in. drive shaft from the gear-box to the bell platform requires critical adjustment of the bearings. A Threaded Coupling (14) is bolted to the outside of the small Flanged Plate on the gear-box in the position shown in Fig. 3 and its furthest cross-bore is located vertically to act as the lower journal for the drive shaft. This 3 in. shaft carries the small Contrate Gear (6) just below the Coupling and is fitted with a small Bevel Gear, Part No. 30a, at its upper end. Before tightening the Bolts on the 2½ in. Angle Girder holding the back of the bell platform to the gear-box, the vertical drive shaft must be tested for absolute free running in the cross-bore of the Threaded Coupling and the hole through the large Flange Plate above. Experienced Meccano constructors will note the unorthodox use of two small Meccano Bevel Gears being used together and although their combined angles are incorrect, the meshing is quite satisfactory for the cam-drive to the bell strikers.

Each bell hammer is a 3½ in. Narrow Strip, fitted with a $\frac{3}{8}$ in. Bolt and lock-nut at its rear end and a ½ in. brass loose Pulley at the other (double lock-nuts) as a striker. These hammers are pivoted on a 3 in. Rod in the Flanged Brackets and spaced by collars as seen in Fig. 2. Each hammer strip has a 2½ in. Meccano Rubber Driving Band looped in its second hole as a return "spring", and passed through the holes below in the Flanged Plate where the bands are trapped by a 2½ in. Axle Rod just wedged in place by internal Collars at each end of the Rod. A good idea of the setting of the hammer cams is seen in the Figs. 2 and 3 where it will be noted that the single "ding' striker (signal to stop the tram) is set apart from the "ding-ding" pair at the other end and strikes the left-hand Boiler End. It is a little less than 90° out of "phase" with the other two cams. This latter pair, set up on the right-hand side of the upper small Bevel Gear are only a 'whisker' out of phase with each other as they must strike the right-hand Boiler-end in rapid succession to provide the "ding-ding" starting signal for the tram. Setting of the "bells" is also very important if the familiar tone of the old trams is to be reproduced realistically. Each Boiler end is locked to its Screwed Coupling by a Bolt and packing Washers for correct location of the striking end of the hammers and then set in place on the vertical rods until the hammer striker gives the correct "pinging" sound. If the bell is too close, the hammer will just make a dull thud on the bell. In fact, in accordance with normal clock practice, the bell hammer has to slightly 'overreach' to give a good bounce off the bell which is essential for an undamped ringing tone. Care and patience at this stage will be well rewarded.

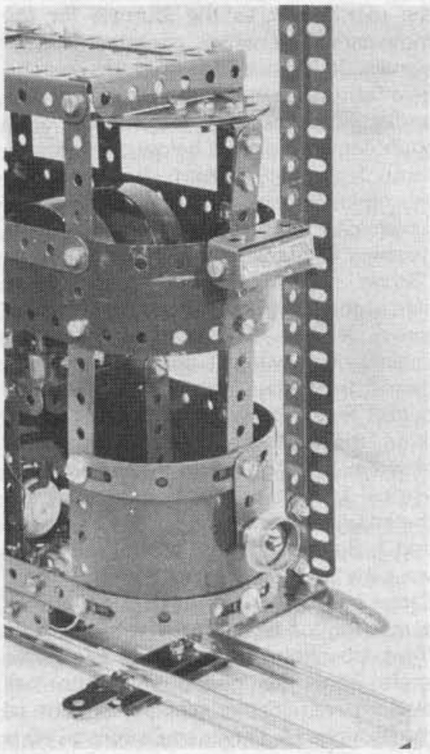
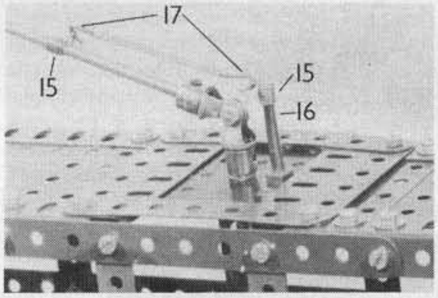


Fig. 4 *Details of tram front end compared with overhead standard. Note insulating strip attaching but isolating the Standard from the track.*

Fig. 5 *Close-up of insulated construction of trolley pole swivel and tensioning spring.*



Setting-up

Sequential operation of the tram should be as follows. Assume that the tram is running (and that the motor is always running whether the tram is in motion or at rest), and that the tram is about to stop. This will be signalled by the left-hand bell-cam releasing its lever to sound the single "ding". Almost immediately after this, the Cam (8) in the main gear-box will have pushed the shaft (7) into the stop position, holding it there for a short period to allow passengers to embark. Meantime the right-hand pair of cams will be just coming up to give their "ding-ding" signal and almost immediately, cam (8) reaches the position where it releases shaft (7). This springs back smartly and brings the Gear (9) back into mesh resulting in the traditional "lurching" start of some of the old trams. Thus the sequence is entirely automatic and if a suitable lay-out of track is available, the whole scene makes a wonderful display model. All shafts in the assembly run continuously as far as shaft (7) which only turns when the tram is actually moving. The body shown in Fig. 1 is just a simple one to give the overall impression of a tram and is based on 7½ in. vertical strips rising from 9½ in. Strip Plates forming the lower passenger car, pairs of 4½ in. Angle Girders make the roof sides, leaving a central gap bridged by 5½ in. Strips to permit the insert of an insulating Fibre Plate on which the trolley pole swivels. Details of this are shown in the close-up of Fig. 5. An 8 in. Axle Rod acting as the trolley pole is universally pivoted in a pair of Meccano End Bearings which swivel on a Pivot Bolt in the centre of the 2½ in. Square Fibre Plate. If End Bearings are not available, the Meccano Universal Joint (Part No. 140) may be substituted. A Long Threaded Pin is fixed one hole in front of the pivot centre and is fitted at its top with a Cord Anchoring Spring (15). Taking a 1½ in. Length of Meccano Spring Cord, this is fitted with Hooks for Spring Cord (Part No. 58b) and then slightly stretched to the form shown in Fig. 5. A second Cord Anchoring Spring is fitted to the trolley pole in the position shown and hooked on to give a pole angle suitable for good contact ofd the 'slipper' on the overhead rail. A flexible insulated wire is connected to the bottom of the Pivot Bolt below the Fibre Plate and passed down to the motor terminal not connected to chassis. Fig. 4 shows how the standards are connected to the tinplate 'O' gauge track by 5½ in. Fibre Insulating Strips which in turn are attached to Flanged Brackets bolted to the base of 12½ in. Angle Girders. A second Flanged Bracket at the top of the girder holds a 3½ in. Double Angle Strip, the inner lug of which is jammed into old lengths of single tinplate rail forming thr overhead pick-up rail. To give clearance above the tram in this particular model, the upper Flanged Bracket is lapped only two holes on to the 12½ in. Girder and its base is supported by a 3 in. Formed Slotted slip which can be seen in Fig 5. A slide Piece is used for the collector or slipper on the trolley pole and this gives very good results on the single tinplate overhead rail. Connecting one power lead to the rails below and one to any trolley standard will energise the whole loop of rails. Experienced readers will note that old pattern Flanged and Grooved Wheels are used in this tram, a choice by Jim Gamble to ensure good adhesion on sharp radius :O. gauge rails. Constructors also using sharp radius rails and the current pattern of Flanged Wheels should arrange for the forward pair of Flanged Wheels to pivot so that they may 'steer' or follow the rail curvature. Alternatively, the design may be condensed to a short wheel base bogie for a larger tram using a second, unpowered bogie either at front or rear. In fact, by using the basic mechanical arrangement outlined here but 'stretching' the whole arrangement, including the bells to lie horizontally under the floorboards of the tram it would be perfectly feasible to make a double bogied Tram with full seating arrangement on upper and lower decks. 'Something for the advanced constructor to think about'.

N.B. 19t Pinion (3) also needs critical lateral positioning for determining the point when the Cam (8) pushes the drive gear (9) out of mesh with Pinion (3).

Check and Report

by James and Rita Vanderbeek

Our Review Models this Month . . .

Ship modelling

It is purely coincidental that we commence our group of product checks and reports this month with three quite different types of marine model. First is the eagerly awaited Matchbox Corvette and this craft is joined, very happily, by the Tid Tug from Duplex Craft. Our third new product is HMS Victory, to 1/100th scale and produced in France. As will be noted, this kit deserves to be rated as one of the finest historical marine subjects ever manufactured in quantity.

Flower Class Corvette — a magnificent Matchbox 1/72nd scale kit

Model marine circles have soon taken to the Matchbox kit for a World War II Corvette. The large scale of 1/72nd has resulted in this craft having a length of over 34 in. with, incidentally, the added advantage that this nominally static display model may be modified to achieve a fully operational replica, with or without radio control.

In typical matchbox manner the components are provided in no less than six colours. Two excellent books of instruction are supplied — one in full colour which covers the development of the full-size Flower Corvettes from a pre-war whaler design and which also includes double page spread illustrations to demonstrate the camouflage schemes for the three Corvettes which may be made from the kit. Thus HMS Bluebell, HMCS Snowberry and USS Saucy are described, whilst on other pages there are colour guides to crew members, equipment and the international code flags. The second book is a 44-page black-and-white production, which covers every constructional sequence involved in the building of one or other ships.

The size of the hull has made it necessary for it to be divided into four units, instead of the usual two, and these are easily cemented together, with plenty of overlap around the hull skin. From thereon the components include every item of externally visible superstructure and equipment, again with the necessary variations between ships.

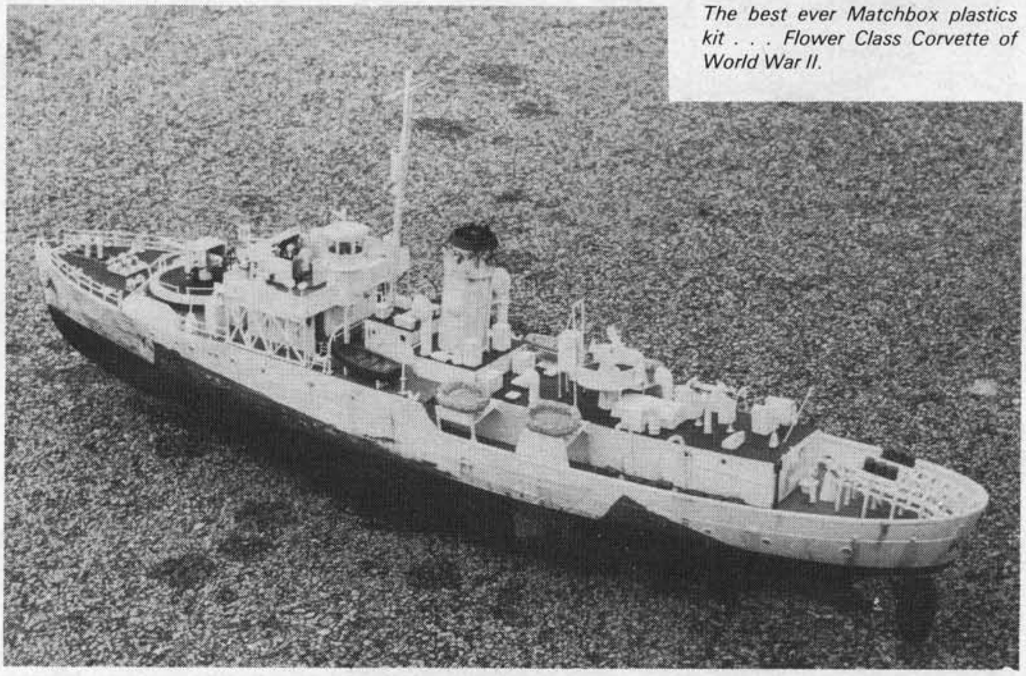
Matchbox do not provide any specific parts or instructions to convert this model into a working vessel, but this task would present little or no difficulty to any modeller with even slight experience of plastics hull models. Already I know that a number of conversions are in hand and, by the time these words are printed, they should be in action with, if the promise of this kit is borne out, every success.

This is by far the most ambitious Matchbox plastics kit yet produced. It is a thoroughly professional job and if it were possible here to award any sort of points rating for quality and real value for money, this Flower Class Corvette kit would be a prime contender.

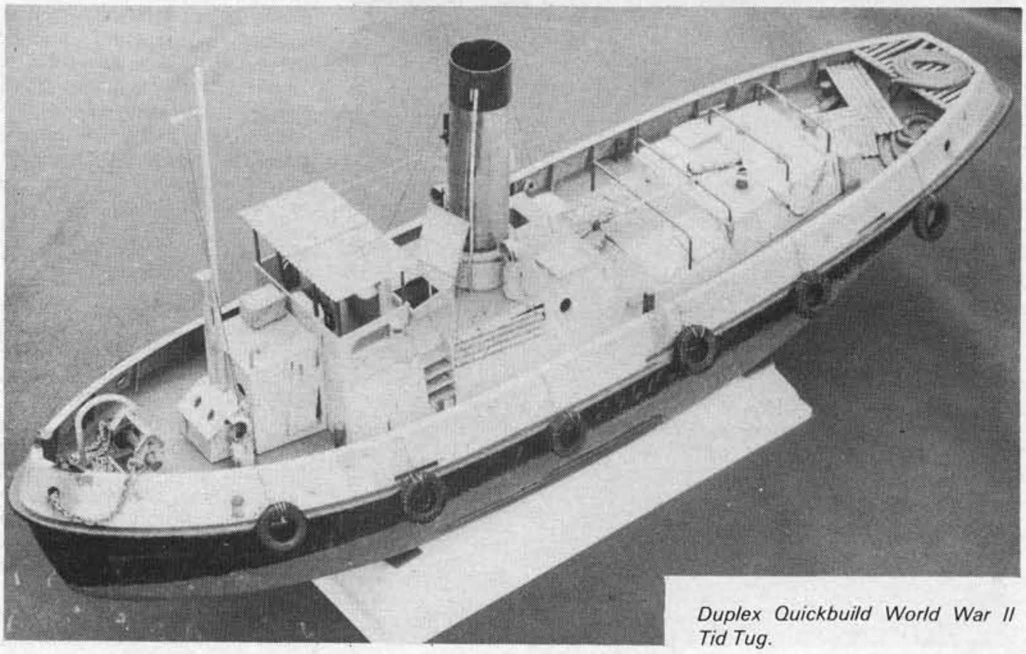
Duplex Quickbuild Kit for WW2 Tid Tug

One of the interesting aspects of this Second World War design is the fact that the Tid Tug may be modelled either as a civilian vessel or as a unit of the Royal Navy. The two are very similar, differing mainly in bridge type and the amount of rust and grime allowed by civilian operators. This Duplex Craft kit is to a Vic Smeed design and features vacuum formed plastics sheet construction for most of the hull and superstructure components. Overall length is 20½ in., with $5\frac{3}{8}$ in. beam, and the tug is suitable for manual control or for single or 2-channel radio.

Kit contents include a pair of hull halves formed from heavy gauge, white coloured, polystyrene sheet, several other vac formings for small units, including the mount for the electric motor, plus printed sheets of polystyrene for items such as the deck, superstructure and other small parts. A special feature of the Tid Tug kit is a formed plastics tray to contain all the small parts — electric motor with shaft and screw, plastics moulded anchor, ventilators, ship's wheel and



The best ever Matchbox plastics kit . . . Flower Class Corvette of World War II.



Duplex Quickbuild World War II Tid Tug.

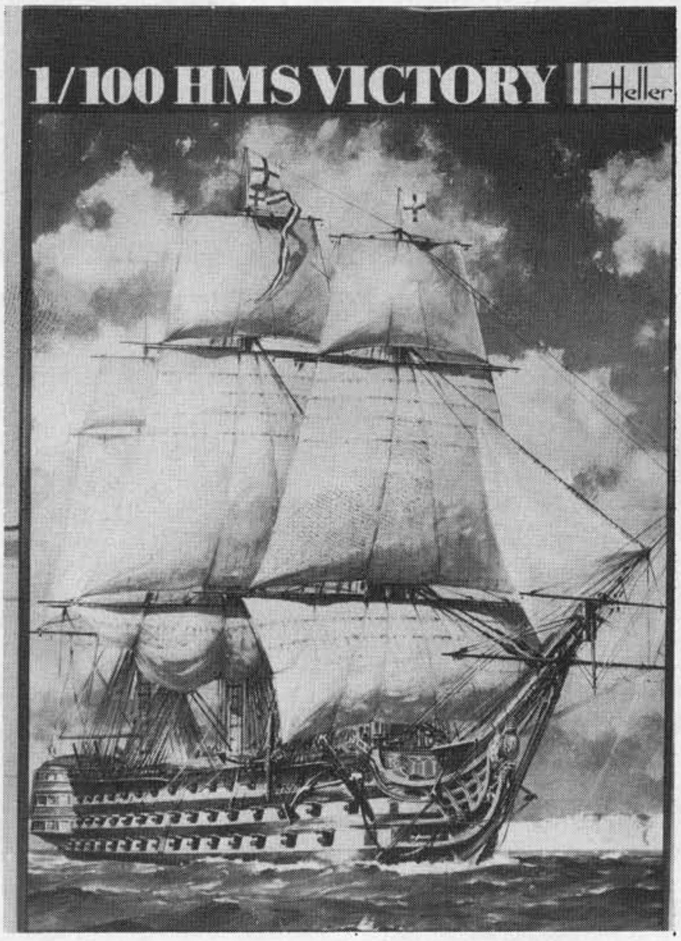
lifebelt. Other items include a plastics funnel, rigging thread, brass wire, dowels, rubber tyre fenders, davits, a bottle of Gloy liquid polystyrene cement and a modelling knife suited to the task of cutting out the sheet plastics components.

There are four large sheets of drawings plus well prepared instructions so that, whilst the job of building the Tid Tug is not one which will be completed in an evening or two, it is, nevertheless, one which can be enjoyed by both newcomers and experienced hands. In particular we regard this outfit as being an honest and good value product — one which seems to have a number of potential modelling and operating advantages.

HMS Victory — Heller's largest and best British marine model kit yet

This is a big kit, in a big pack! The Heller HMS Victory to 1/100th scale contains about 1,900 parts and the finished model of Nelson's Flagship has a length of 1,100mm (43¼ in.) and height of 698mm (about 27½ in.). These two guide dimensions illustrate the point that in this scale HMS Victory is very large, very impressive and best built by modellers who have had, at least, some experience of similar though smaller marine subjects.

The Signal box from Jouef HO scale kit.



To offer a detailed review of this kit in the space available to us would be near impossible. Perhaps it is better, therefore, to remind readers that this manufacturer has a remarkably good track record in the tooling and production of maritime subjects, and that this is probably the largest and most involved that Heller has ever tackled. It is almost superfluous to mention the usual desirable attributes — all are included and/or incorporated, so that HMS Victory is in a model building class all her own.

Interesting diesels for the HO scale Jouef system

A two-coach DMU and an 0-6-0 diesel-electric shunting loco are amongst the latest releases from Le Jouef Francais. Several hundred diesel trains like the Houef model are in service in France, for the Type XBD 4737 has been in production since 1963. Reduced to HO scale, this striking red and cream finished unit is as attractive as its prototype, for the ribbed surfaces of the coach roofs and sides, the folding doors, obscured glass toilets, wrap-round cab windows and fully fitted-out interiors are absolutely typical. Other features include the separately fitted roof vents and the neat, compact bogies with their full complements of brake and suspension detail.

In choosing the diesel electric shunter of Type C 61004 as one of their 1979 new models, Jouef were obviously well advised. This 0-6-0 unit, with its outside frames, articulated side rods, hand-rails all round, glazed cab and accurate green/yellow livery is not only a fine representative of a typically French utility loco class, but adds to the range a model which is capable of tackling almost anything that may be asked of it.

It was on test that the DMU provided us with a big surprise, for it turned out to be one of the fastest HO models we have ever operated. The power car is designed to run either with one trailer car to make up a standard two coach unit, or with one or two additional units coupled up. Suffice to say that our impression was that, even as a six-coach train, this new model would have little difficulty in taking on. and probably beating, a high-speed train.

In some contrast, the diesel shunter behaved precisely according to type. It is a powerful little machine, well geared to achieve satisfactory performance and it made light work of express length rakes with a few extra freight wagons added on for luck. Like the DMU it responded accurately to our AGW controller movements and, again, we can find little to criticise in this model.

Other new Jouef items which are now in the shops include two new HO scale plastic kits — the first for an old-time country signal box, to match the station and water tower recently released, and a road service station. This latter kit is one of the best of its type we have ever seen, for it not only features three colours of structure plus transparent mouldings, but also provides material for the grass verges and a superb set of colour printed posters, fascia panels, shop window displays and fuel pump insignia — all ready to be cut out from self-adhesive material and affixed in place. Needless, to say, these decorative items are all supplied in three languages, as are the illustrated instructions.

The latest Hornby book

Only rarely do we mention books devoted to the model railways scene, for any attempt by us to cover the many volumes published each year would result in this becoming a book review feature, rather than one devoted to the actual hardware.

We make an exception in the case of The Hornby Book of Trains 1954-1979, because this is no ordinary model work, but one linked specifically to the development of what was originally Tri-ang Railways and which is now proudly titled Hornby Railways. The story of this 00 gauge system is well told, and its progress and expansion in the years since the early 1950s has been traced with almost total accuracy. The fact that this 176-page volume has been edited by S. W: Stevens-Stratten, FRSA must have a great deal to do with these high standards.

Of special interest must be the feature on the first Tri-ang/Hornby loco — the 4-6-2 Princess Elizabeth. This has been prepared by R. Richard Lines and traces the many versions of this model (almost 880,000 were built), from the original all-black, plunger-contact type through the many other green and maroon liveried Princesses to, as a result of totally new tooling for the whole model, the tender driven successor, 6233, Duchess of Sutherland. This story is worth recording, for this locomotive and the 0-6-0 tank may truly be said to have established the foundations of the whole system.

Other sections of the book are devoted to some of the fascinating aspects of modern design, tooling and production, whilst modern image enthusiasts — and that includes an ever-increasing proportion of younger Hornby users — are treated to up-to-date information on the latest British Railways ultra-fast trains, train control and freight operation.

The production standards of this

book are excellent. Illustrations are represented by full colour and black-and-white photographs in profusion, whilst the diagrams used to clarify many of the operating systems are clear and easily understood.

This is a real collector's book, with a pleasing balance between the many subjects which must be included in a work of this kind. It is also quite remarkably good value for money and deserves to live, not on the bookshelf, but beside every Hornby layout.

Silicon chip featured in new Radionic Kit

In our recent Winter Modelling Feature, we referred to the new group of Radionic Experimental Kits which incorporate one or more silicon chips. The smallest of these is the Audio 5, in which its single chip is an Operational Amplifier which, in this kit, results in improved performance and greater output than would otherwise be possible. Besides the chip the pack contains various standard type components — resistors, capacitors, inductor coil, ferrite rod, transistors and a light dependent resistor. In addition, there is a loudspeaker which can be mounted directly beneath the surface of the moulded plastics circuit board, various nut and bolt fixings, plus connecting wire, battery clips, on/off switch, and, very important, a set of coil spring type connectors for the solder-less circuitry.

The only extra required is a pair of PP3, PP6 or equivalent batteries. The set provides for building up an AM/MW radio, plus burglar alarm, skin resistance tester, water level detector, and a Morse Code trainer. All of these circuits may be satisfactorily assembled on the board, which itself is interesting as not only are the locations for the connectors and components provided but the basic circuit diagram is engraved onto its top surface.

Backed by a well written 24-page instruction booklet, the Audio 5 proved to be notably snag free. Soon after starting our radio rig the sound of music by BBC was with us — clearly and with a pleasing maximum volume for a set of this basic type. The same success accompanied our further circuit checks, so we have no hesitation in recommending the Audio 5, or its larger Radionic counterparts with which many more such experiments may be carried out. Finally, mention should be made of the fact that a set of this kind can be handled by even the youngest electronics enthusiasts with every chance of success.

Slater's wagon kits in 00 scale

Long one of the most reliable sources of kits and materials for model railway builders in 00 and associated scales, 0 and N gauges, Slater's Plastikard has built up an enviable reputation.

The arrival of a pair of this company's latest 00 scale wagon kits gave us an opportunity to check out current production and, in the event, to determine that their popularity with knowledgeable enthusiasts is truly merited. The first kit was that for a Chas. Roberts, 7-plank, end door wagon, finished in the red, white and black colours of Vauxhall Colliery. Of special interest is the fact that the moulded plastics wagon body is supplied fully finished and so, after assembly, is equal to the best ready-to-use wagons as far as printing is concerned, but with the added advantages of tooling to the most critical modeller's standards. The same attention has been given to the wagon underframe, which has its moulded components supplemented by a set of metal buffers and a pack of correct type, split spoke wheels with metal bearings, from the Maygib Components range. The final touches are added by a pair of standard type auto-couplings and a set of Slater's private owner numeral transfers.

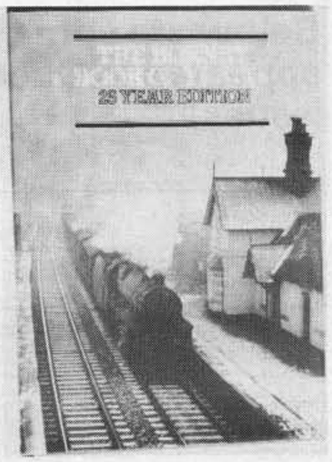
From a parallel Slater's wagon series comes a kit for a North Eastern, 20 ton hopper wagon — characteristically with high-sided, tapered wooden body. Here again the components are precisely moulded, whilst there are separate wire hand-rails, appropriate transfers and the same Maygib wheels and bearings as in the private owner vehicles.

The Slater's kits provided interest and enjoyment in their construction and finishing. The resulting models not only looked very fine replicas of their prototypes, but ran perfectly and are thoroughly to be recommended.

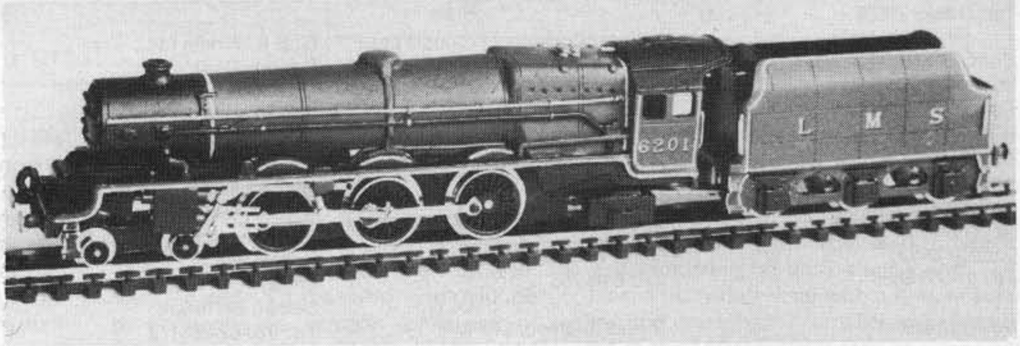
Another Classic Car joins the Heller 1/24th scale range

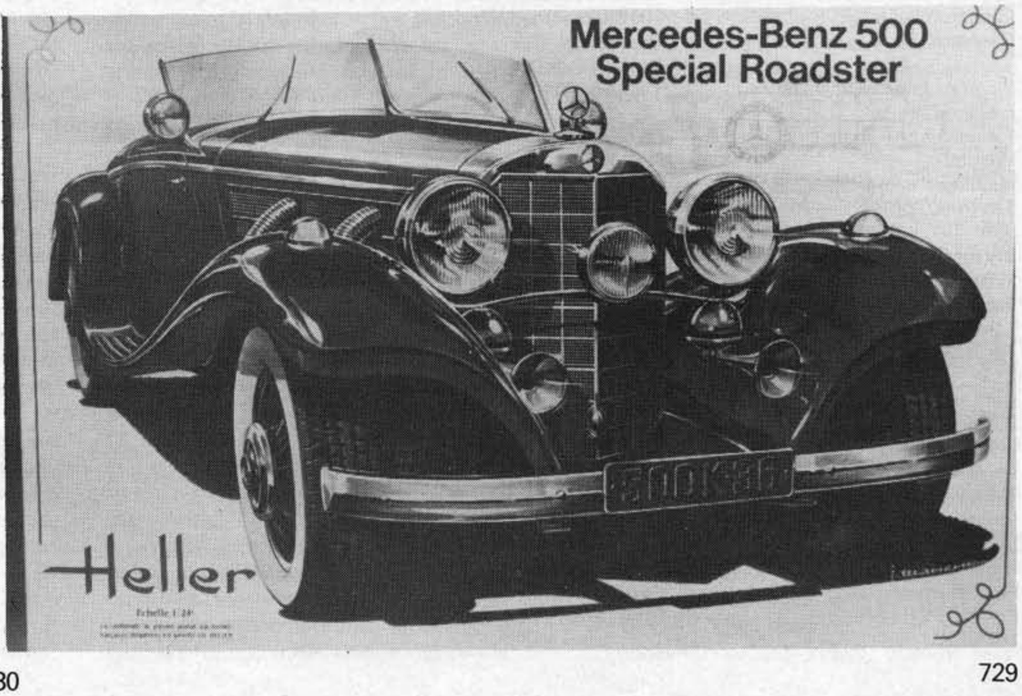
In a range which already includes a Delahaye 135, Hispana Suiza K6 and the post-war, gull-wing, Mercedes 300SL, the arrival of the pre-war Merc 500 Special roadster can come as no surprise. This example of Germany's superb automobile engineering in the 1930s comes as a 119-piece Heller kit, with the main body components in red, engine and suspension units in dull metallic silver, and a set of flexibly moulded, fully-treaded tyres. There is also a separate set of mouldings for the transparencies, including windscreen, side screens and lamp lenses.

The construction of this model is in many ways a parallel to the previously announced models, but this Mercedes is remarkable for its multitude of bright plated parts. These include not only all the bits and pieces that one would expect to be chromed, but some larger items such as door panels, door trim and the bonnet side panels. Obviously, the idea is that the excess plating will be painted over, leaving only the parts which should properly be chromed but, in the hands of younger modellers, we can foresee some very decorative Merc 500s being



The LMS 4-6-2 Princess Elizabeth locomotive from an N-gauge white metal kit from D&M Castings.





displayed with price, if not astonishment!

Correctly painted and finished, however, this latest Heller model is a worthwhile example of between the wars sports car development and, as such, deserves a big welcome from automobile kit enthusiasts.

And now . . . an LMS Princess for N gauge modellers

A new British outline Pacific in N-gauge is something which will please a great many modellers. D. & M. Castings have the white metal kit for the LMS Princes Elizabeth 4-6-2 at a stage where stocks should be available by the time these words are in print, but have provided an advance set of components for us to examine.

The Princess is one of the most important projects which this relatively small company has yet undertaken in N-gauge and the results, based on our pre-production example, are good. The loco body casting brings out the finely tapered lines of the Stanier boiler and displays externally visible detail of the prototype. Again, the loco is designed to accept the Graham Farish 'Black Five' 4-6-0 chassis without modification, so it starts with the built-in advantage of a thoroughly reliable power unit. Graham Farish components are also supplied in the form of the additional wheels — of latest type with metal axles and plated tyres — whilst the smaller white metal components include everything from the tender sides to foot steps and vacuum pipes.

This kit will, we feel sure, be very popular for a colour photograph of one of the fully-finished and lined-out pre-production models shows off to perfection the excellent proportions and detail of this N-gauge loco which, seemingly, is not available elsewhere.

Below are some helpful addresses which have appeared in Check & Report during the past few issues.

Airfix Hobby & Toy Sales Ltd.,
Haldane Place,
Garratt Lane,
London SW18.
Tel: 01-874 7292

Horby Hobbies,
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Kent.
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Actiongable Ltd.,
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Tel: 01-352 8885

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1 Beresford Avenue,
Wembley,
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Tel: 01-903 5211

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Tel. 01-980 4321

Denshi-Gakken (Electroni-Kit),
20 Bride Lane,
Ludgate Circus,
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Tel: 01-353 6430

Eisenmann & Co. Ltd.,
Lima Trains,
80 Clerkenwell Road,
London EC1M 5SU.
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Apem Estate,
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Liliput Model Railways (UK) Ltd.,
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Tel: Bala 753

Malins (Mamod) Ltd.,
Thorns Worls,
206 Thorns Road,
Brierley Hill,
W. Midlands DY5 2JZ.
Tel: Lye 2244

Meccano Ltd.,
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Liverpool L13 1 DA

Mettoy Playcraft Ltd.,
Mettoy Centre,
Hill Close,
Lodge Farm Industrial Est.,
Northampton NN5 7XA.

Radionic Products Ltd.,
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Bristol BS17 5RB.
Tel: Chipping Sodbury 316774

Revell (G.B.) Ltd.,
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Potters Bar,
Herts. EN6 3JX.
Tel: Potters Bar 58261

Slater's Plastikard Ltd.,
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Matlock,
Bath,
Tel: Matlock 3993

W. & H. Models Ltd.,
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Tel: 01-935 8835

G. & R. Wrenn Ltd.,
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Basildon,
Essex.
Tel: Basildon 20541

Graham Farish,
Romany Works,
Wareham Road,
Holton Heath,
Poole,
Dorset. BH16 6JL.
Tel: 020-62-2681/2

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Chiostergi 15,
20153 Milano, Italy.

Lone Star Products,
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Märklin Model Railways,
37 Birdhurst Rise,
South Croydon,
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Jouef,
72 Rue des Archives,
Paris (3),
France.

Fleischmann,
27 Richmond Place,
Brighton
BN2 2NAß

Proops Bros. Ltd.,
The Hyde Industrial Est.,
Edgeware Road,
London NW9 6JS

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Coalville,
Leicestershire LE6 2DE

Modelcraft,
5 Cross Street,
Blaby,
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Combined Optical ind. Ltd.,
Bath Road,
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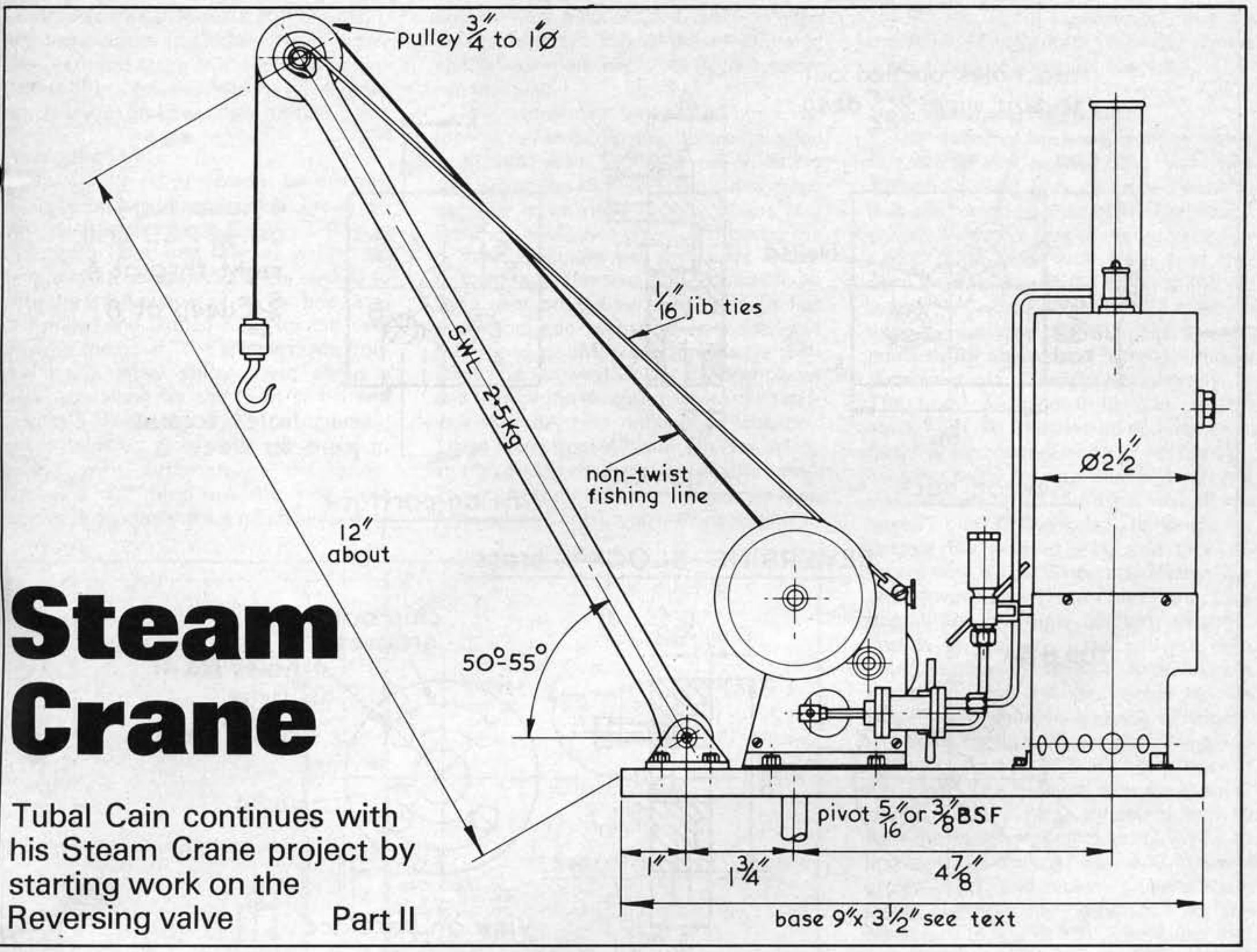
Beatties (North London),
10 The Broadway,
Southgate,
N14 6NP



Steam Crane

Tubal Cain continues with his Steam Crane project by starting work on the Reversing valve Part II

Reversing Gear

MAKE THE BLOCK first. Face both sides and then mark out for the ports, noting that two on one diagonal go only half-way through, two on the other right through. These are all drilled No. 41. Drill the centre-hole a close 6 BA clearance fit. Turn over and very carefully enlarge the two ports showing on that side, to half the thickness to be a close fit to the pipes you are using — $\frac{1}{8}$ in. or $\frac{5}{32}$ in. to choice ($\frac{1}{8}$ in. makes the pipework easier, but make sure it's fairly thin-walled stuff). Now drill the access holes in the two opposite sides to meet the other pair of ports as shown on the drawing.

The valve is faced in the lathe and the middle hole drilled from the tailstock. Mark out for four No. 41 holes one at each end of the banana-shaped slots. These holes will, or should, match up with those in the block. Now make a little chisel out of $\frac{3}{32}$ in. square silver steel and carve out the bananas. They don't need to be more than $\frac{1}{32}$ in. deep, nor need they be the exact shape, provided there is a reasonable flat surface between them and the centre hole or the edge. If by any mischance you mark the flat face, which might cause a steam leak, return to the lathe and reface. Once finished, part-off to thickness. (It's far easier to hold when making the grooves if you do this on the large chunk of stock.) Slip a 6 BA bolt through and grind the two faces together, starting with the very finest emery, or even pumice powder, and finishing with rouge or Brasso. You should get a dull, not a polished surface.

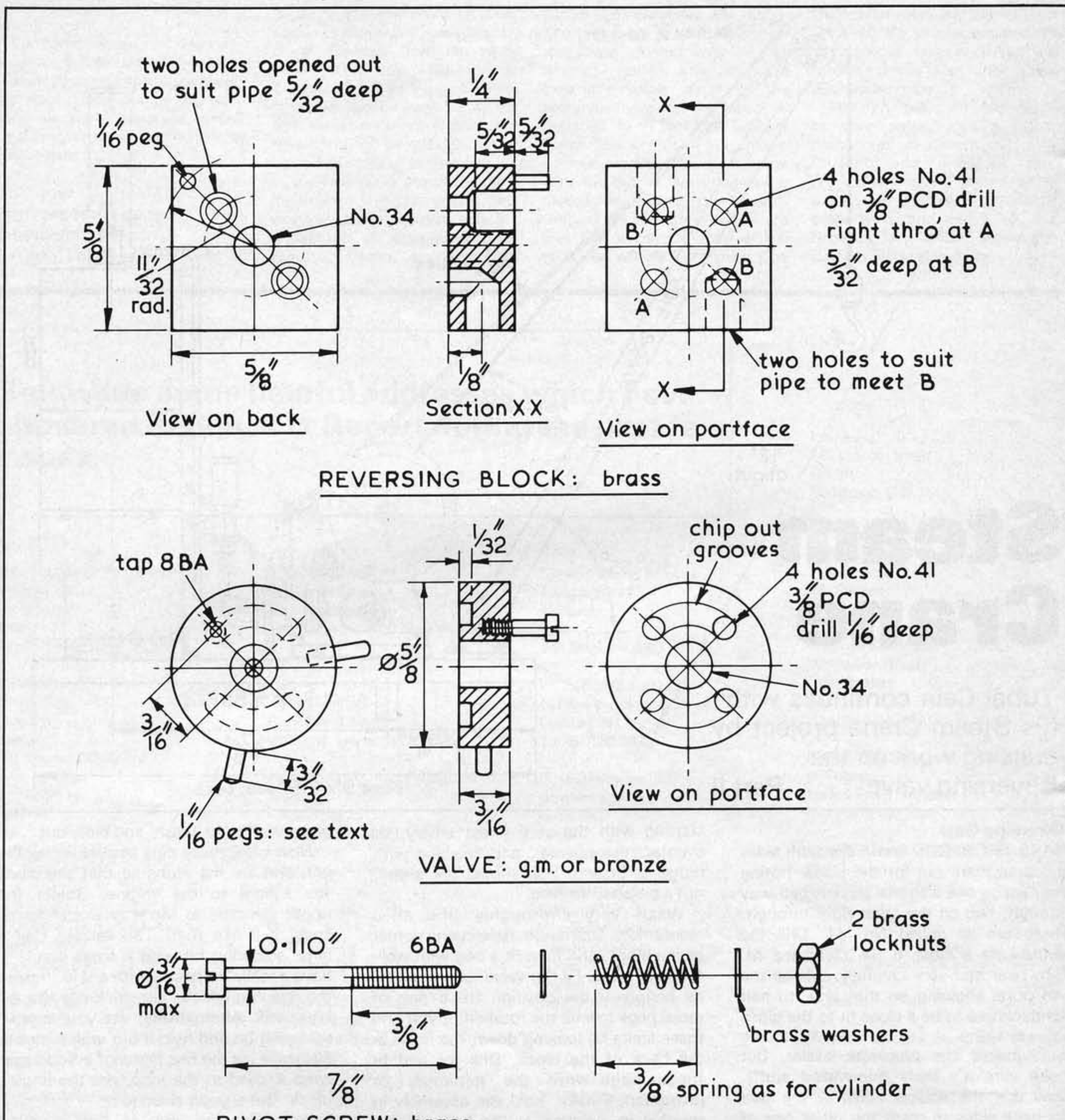
Wash very thoroughly and then reassemble. Drill a $\frac{1}{16}$ in. hole in one corner of the block, and then fit a peg with well-rounded ends. Fit the valve, and mark on its periphery the position for a pair of radial pegs to limit the rotation — you find these limits by looking down the holes in the back of the block. Drill for and fit these pegs with the minimum of projection. Finally, hold the assembly in roughly its position at the back of the winch, between the engine standards; mark the top with letter "T" and also mark for the little 8 BA screw on the back of the valve to which the operating rod will fit. Drill and tap for this, taking care not to go right through the valve.

Pipe fitting

Make up the pipes as shown. Bend up the U-shaped link-pipes first and offer them to the engine standards, adjusting till they look well and fit well. Make two short stubs and fit these into the reversing block; hold this in place and make a mark on the link-pipes. Take all apart, file one end of each stub to a 90° point, and similarly file a 90° vee at the marks on the link-pipes. Make sure they fit closely, remove burrs and blow out with air. Clamp each stub to its link and braze up. Pickle, wash, and blow out.

Now offer these pipe assemblies to the job, and file the stubs so that the block sits square to the engine. Solder the upper link-pipe to the engine standards. Easy, just like that! The secret? Use a large soldering bit with a small end — I have a really hefty one with a $\frac{5}{16}$ in. hole in the end into which I can stick any shaped bit at will. Alternatively, use your normal soldering bit and help it out with a mouth blowpipe, or the fine flame of a Soudogaz lamp applied to the *pipe*, not the engine block. Get a good clean joint — it shows. Now solder the stub to the reversing block. Same procedure helps. You must then turn the job over and fit the lower pipe — doing the joints in the same order. Take care (a) not to get solder running into the pipes and (b) that the lower link-pipe doesn't stick out below the bottom edge of the winch plates. Clean everything well.

Fit a 6 BA round or cheesehead screw, put on the valve-disc with a spot of oil or grease, a washer, a spring like those used on the cylinders, another washer and a locking nut. Unlike the cylinder pivot spring, this one needs to be fairly well screwed up, as the steam pressure has a larger area to work on. You can now make and solder in the steam and exhaust connections to the back of the block, as shown on the drawing. Then, apply compressed air, or steam from a test


two holes opened out to suit pipe 5/32" deep
1/16 peg
5/8"
No.34
11/32" rad.
5/8"
View on back
1/4"
5/32"
5/32"
1/8"
Section XX
X
X
B
A
B
A
4 holes No.41 on 3/8" PCD drill right thro' at A 5/32" deep at B
two holes to suit pipe to meet B
View on portface
REVERSING BLOCK: brass
tap 8BA
3/16"
3/32"
1/16" pegs: see text
1/32"
Ø5/8"
3/16"
chip out grooves
4 holes No.41 3/8" PCD drill 1/16" deep
No.34
View on portface
VALVE: g.m. or bronze
0·110"
Ø3/16" max
6BA
3/8"
7/8"
2 brass locknuts
brass washers
3/8" spring as for cylinder
PIVOT SCREW: brass
steam inlet
rod to reverse lever
to exhaust
Note: fit pivot screw before pipework
Ø5/32" pipes soldered into blocks
REVERSE VALVE & PIPEWORK
Fig. 6

boiler, and try her forward and reverse. If you have a little pot boiler this is better than air at this stage as it will show up any leaks better. Besides which, all engines run far better on steam than on air.

Reversing Lever

I have given no dimensions for this as it offers an opportunity for artistic design on your part! You will see the way I did it in the photo. The little bracket is filed up from a bit of scrap brass angle, drilled to pass the 6 BA spacer screw on one face, and drilled and tapped 8 BA for the lever pivot on the other. The lever is made from $\frac{3}{16}$ in. × $\frac{1}{16}$ in. steel strip, drilled about a third way along for the pivot screw and tapped 8 BA at the end. The operating link is bent up from a bit of 18 s.w.g. spring wire softened at the ends. Locknuts are used on the two little screws. You can make it much simpler of course—just a bit of wire to pull up and down, through a hole in the winch frame spacer—or more elaborate if your tastes run that way.

That completed the winch, but I will mention a few odd points before going on to the next item. The ½ in. pinion on the second motion shaft can be thinned down as there is no need for the ¼ in. face width on this job. I chucked mine by the boss and reduced it to $\frac{5}{32}$ in. wide on the toothed face. Use two grub-screws on the large gear on the winding drum; it has quite a torque to handle and one isn't really enough. (Meccano threads are $\frac{5}{32}$ in. Whit., by the way) On the cylinder pivots and that for the reversing valve I used self-locking 6 BA nuts rather than locknuts. These came from Whistons at New Mills, and come in very handy on jobs like this. The grub-screw in the winding drum is an Allen socket head type—an exception to my remarks about screwdrivers, but this one must be really tight. I think the photos should clear up any other queries.

Stop Valve and Lubricator

The reversing valve will work as a stop and start valve as well, but you need something a bit finer for speed control; and a lubricator is advisable. The design shown is more or less as that provided by LBSC and you will find that my description is almost the same as the old maestro's "words and music". I make no excuse—the one I made has worked perfectly for a quarter of a century; I only hope some of my designs last as well!

The body is made from $\frac{5}{16}$ in. square stock—$\frac{3}{8}$ in. A/F hex would do—the ends faced to $\frac{7}{8}$ in. overall length. I have a self-centring 4-jaw for this sort of work but you can set up in the usual way if you haven't one. Drill $\frac{7}{32}$ in. to $\frac{3}{8}$ in. deep, flat bottom the hole to $\frac{7}{32}$ in. and then re-centre with a little Slocumbe after which drill down No. 41 to 13/16 in. total depth—just not quite breaking through. Tap ¼ in. × 40 using the tailstock drill-chuck to guide the tap true. Remove from the chuck and drill $\frac{5}{32}$in. holes for the spigots of the unions and the lubricator. Get them the right way round! The gland is made from a bit of brass hex. Chuck in the 3-jaw, face the end, turn down to ¼ in. dia. for $\frac{3}{16}$ in. and thread ¼ in. × 40 with the tailstock die-holder. Drill No. 30 and tap right through $\frac{5}{32}$ in. × 40. Reverse in the chuck and repeat. I use a spare union nut from my "bits" box for the gland nut. (If you do that, check first that it is 40 t.p.i., as some are 32; cut the thread to suit in that case.)

This spindle is stainless steel and should present no problems. Make the cone on the end 60° for fine control. I silver soldered a brass boss on the end, cross drilled afterwards for the handle. Don't you do that! Cross drill the boss first, then drill and tap a $\frac{5}{32}$ in. × 40 thread, thread the end of the spindle, assemble all, and then braze (or even soft solder) the lot. The two union stubs should be threaded to suit the union nuts you are going to use; one of mine was 40 threads, the other 32. The lubricator is a simple turning job from $\frac{7}{16}$ in. brass rod. The only snag is the small hole in the lower end. If you haven't a No. 70 drill (0.7 mm.) use the smallest you have—say No. 60—and burr the end a bit till a 24 or 26 s.w.g. wire just fits.

The union bosses and the lubricator body are all three brazed in at one go, but take care again that they face the right way. Lubricator on top, unions pointing downwards and one to your left when looking at the handle end. Here a word about "handing" may be apposite. Quite a high proportion of the population is left-handed. If this applies to the youngster concerned, hand the whole winch—put the gears on the opposite sides to those shown, the reversing lever on the opposite side, and make the throttle valve opposite way round too. This brings the

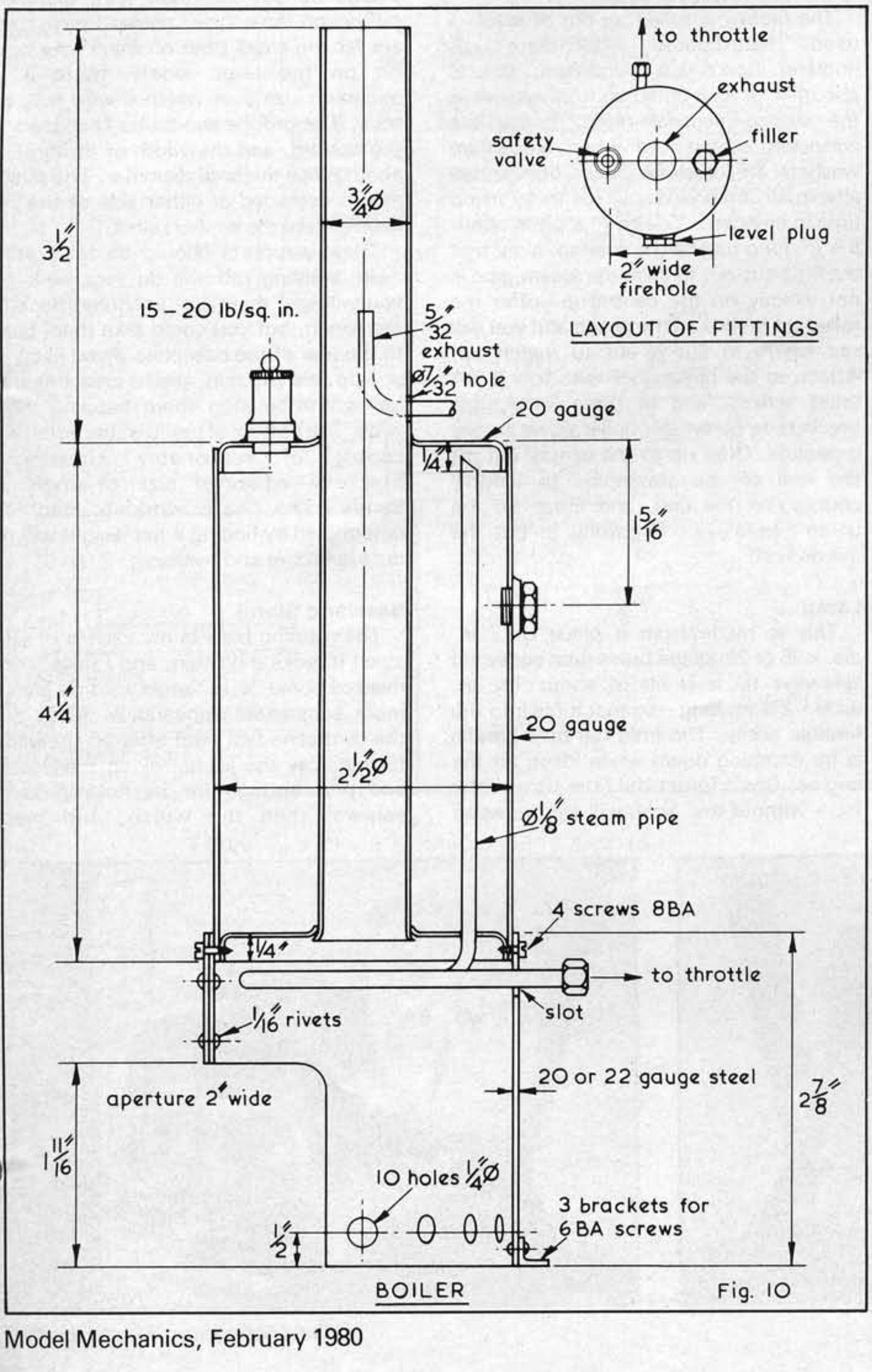


Fig. 10

controls to the left-hand side of the crane (looking at the boiler end) and will be more natural for the driver when he (or she) stands behind the crane to work it.

There is no need for any support bracket, though you can make one if you like. The lower union stub is attached to the vertical pipe from the reversing valve; the other goes to the steam-dryer pipe from the boiler, and these hold the job firm enough.

Boiler

This is 2½ in. dia. × 4 in. long in the shell—you need a piece 4¼ in. long to allow for the flange. These sizes are not critical, and for jobs like this I tend to use the tube which is to hand or (more important) one for which I have flanging plates already! 29 s.w.g. is quite thick enough at this pressure (20 p.s.i.) The flue is ¾ in. copper water pipe, or the metric equivalent, and the end plates 18 or 20 s.w.g. sheet flanged to fit inside the shell. You will see from the photo that I have domed the top plate upwards as in real practice, but this isn't essential. You need bushes for the safety valve, water level plug and filler plug. I always make this separate from the safety valve, to reduce the risks of youngsters interfering with the setting. You can, of course, add fittings to your heart's content—level gauge, pressure gauge, and even a feed clack, pump, and water tank; but I think that the addition most likely to be appreciated is a whistle. This will not only use up surplus steam, but also serve to give warning to the cat that she and her basket are about to take a trip upwards!

I needn't go into detail on the brazing job, as you can refer back to the pot boiler described earlier in the year, but when putting all together arrange for the safety valve to be on the opposite side of the crane to the throttle valve and reverse lever. The steam pipe, as you can see, runs up inside the boiler—bevel the top of the pipe at 45°—and is curled round once in the "flame box" to act as a mini-superheater. When brazing up, see that this comes out at the winch side. It can be a nuisance handling this on the hearth, so curl it up in a coil whilst brazing, but make sure you don't braze the pipe to the boiler bottom by accident! You should be able to braze (silver solder) all up in one heat, after which test for leaks and give a pressure test in the usual way. Give a good rub with fine wire wool and then polish. Lacquer it if you have any which will stand the heat.

The plugs on boiler and lubricator should all have the same hexagon size and the safety valve any type that suits you. Mine is one that has been sculling around for 20-odd years, but if I had had to make one I would have used either a loco type from the LBSC book or one like that on the boiler described earlier. A note about the spring. Use bronze, of course, but the trick for low pressures is to use a long spring—one with plenty of coils—so giving more adjustment for a given pressure change. Wind it close coiled round the "mandrel" and after squaring the ends on the grindstone stretch it out to the length you need.

The firebox is rolled up out of steel—I used lead-coated "ternplate"—or tinplate. *Don't* use aluminium; this is about as far as it could be from copper in the electro-chemical series, hence the corrosion experienced when aluminium washers are used on boiler fittings; an aluminium firebox would rot away in no time in any case. You need a piece about 8¼ in. long to give the overlap. Note that the little cut-out to clear the steam-pipe is not exactly on the centreline—offer the rolled-up firebox to the winch and you will see where to cut it out to match up. Attach to the boiler shell with four 8 BA brass screws, and fit three little angle brackets to screw the boiler down to the baseplate. Offer up to the winch, cut off the end of the steampipe to length, countersink the end, and braze on the union nipple—*not* forgetting to put the nut on first!

Lamp

This is made from a piece of 2 in. dia. × 26 or 28-gauge brass tube squeezed sideways till it is about about 1¾ in. wide × 2¼ in. long—so that it fits into the firehole easily. The little hat-on-a-handle is for damping down when idling on the engine. Don't forget the little hole in the top—without this, spirit will tend to weep out from the wick. You will see that I have shown no filler plug; I find it just as easy to lift a wick out and fill that way.

If you are going to use Meta fuels, make a sort of fence round it. Use fairly coarse mesh wire, make the legs about $\frac{3}{8}$ in. tall and the fence round it about the same. It will need a little handle, and you'll have to buy or make a pair of tweezers so that the fireman can stoke to the back of the fire when need be.

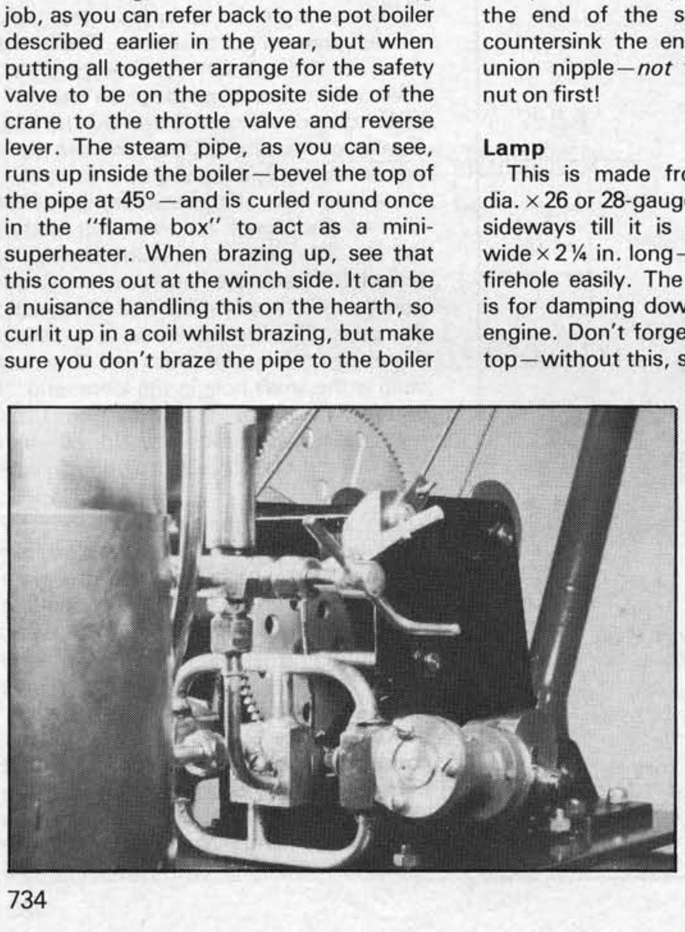
Jib

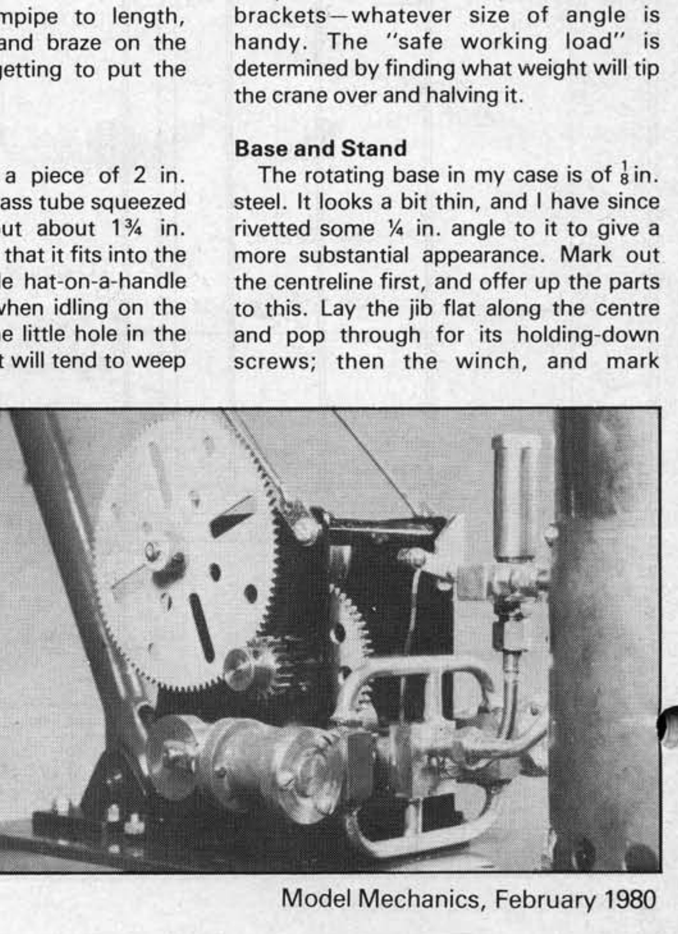
As I said at the beginning, this can be made to suit yourself and the contents of your scrap-box. A hexagonal or octagonal timber jib is quite attractive—there was just such a steam crane as this at a little country goods yard when I was a boy which had a timber jib; it was tapered at the ends and had a slight belly in the middle. The pulley axle and the jib pivot should be not less than $\frac{3}{16}$ in. dia. The pulleys on most "toy" cranes I have seen are far too small (that on mine may be a bit on the large side!)—there is a minimum size over which a wire may be bent. The groove should be U-shaped at the bottom, and the width of the groove about twice the cord diameter. The pulley axle is extended at either side of the jib-head to take the support sires.

These supports should be fairly stiff; $\frac{1}{16}$ in. welding rod will do very well. As you will see, mine are anchored back to the winch, but you could take them back to the rear of the baseplate if you liked. If you do this you may need a crossbrace at half-length to stop them flapping sideways. The bottom of the jib is supported in a couple of reasonably substantial brackets—whatever size of angle is handy. The "safe working load" is determined by finding what weight will tip the crane over and halving it.

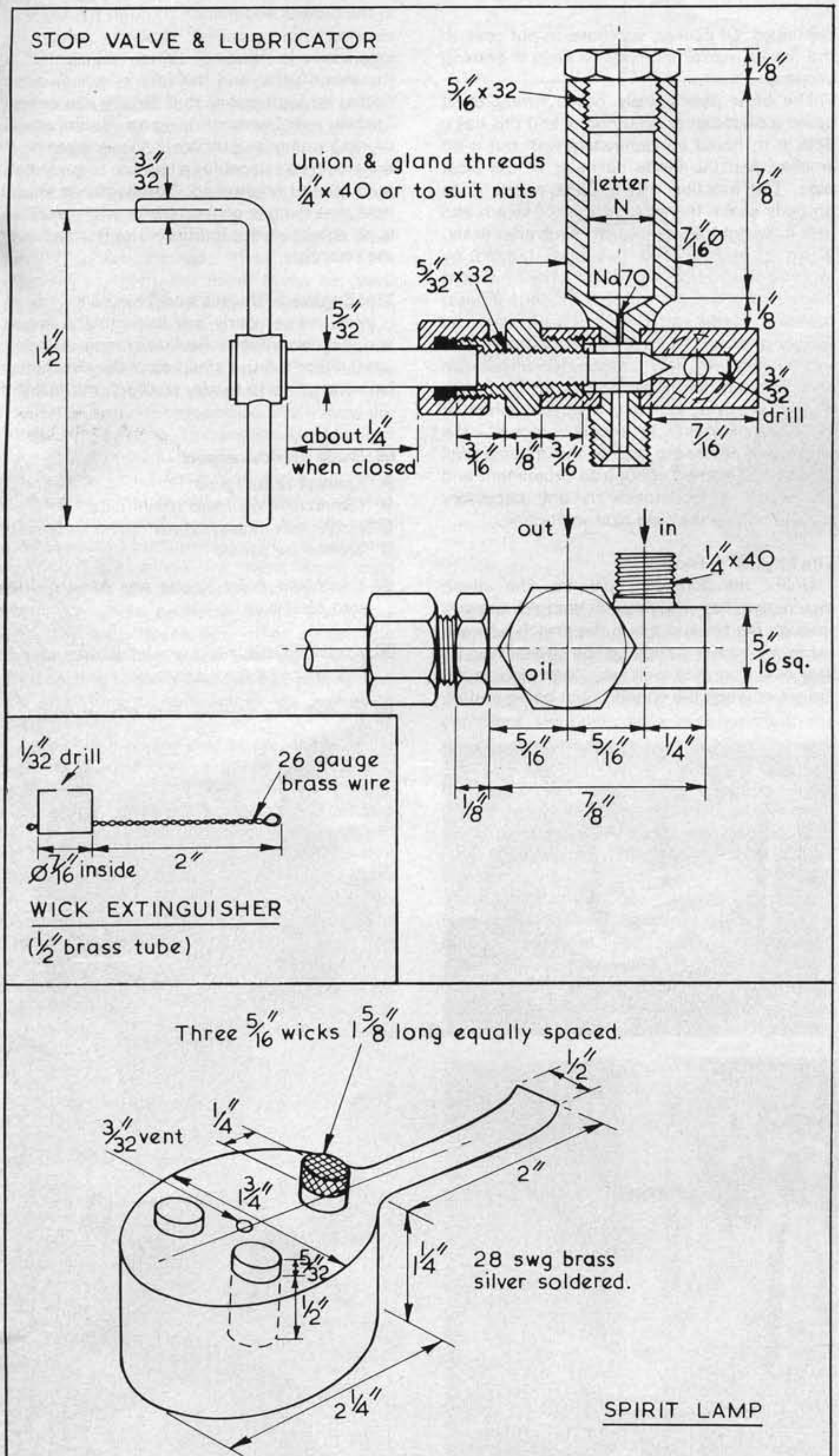
Base and Stand

The rotating base in my case is of $\frac{1}{8}$ in. steel. It looks a bit thin, and I have since rivetted some ¼ in. angle to it to give a more substantial appearance. Mark out the centreline first, and offer up the parts to this. Lay the jib flat along the centre and pop through for its holding-down screws; then the winch, and mark





through for that; finally the boiler. Adjust the overall length of the plate to leave a bit sticking out behind the boiler. Now mark out for the centre pivot bolt—$\frac{5}{16}$ in. or $\frac{3}{8}$ in.—and make sure that its head won't foul the flywheel. (If it does, either reduce the head or move the wheel.) Drill through all fixing holes, and countersink below, or, if you are using wood, drill the appropriate pilot hole. Fit the pivot bolt before attaching the parts. Fit the exhaust pipe at the very last. You can close the exit to a nozzle if you like, but it isn't really necessary. The main reason for exhausting up the stack is to ensure that drops of dirty water come out at a point where no-one's eye is likely to get in the way. You could take the thing up through the firebox and the inside of the flue, thus boiling off any water drops, but it would be a bit of a pig to wangle it in. Though not shown on the drawings or photos I recommend that you fit a small "pot", say $\frac{5}{8}$ in. dia. × 1½ in. long, at the foot of the exhaust pipe, and feed the exhaust from the cylinders into it about half-way up.



This will trap oil and condense water drops, and make the lady of the house far more tolerant when the crane is used in the kitchen. Fit a little plug or cock to drain it at intervals.

The fixed base can be made to suit you—I give one suggestion. My own was to have been mounted on the loudspeaker from a defunct radiogram, which, being heavy and about 9 in. dia. on the frame, would have been ideal. However, looking for this in my junk-hole I fell over the base of a sun-lamp which came to use along with a box, several flower-pots and a few other odds for 10p at a local sale (we wanted the wooden box) and this is what I used. It looks quite well and is heavy enough not to tip over. The hole in the top was dead right, too! The one point to watch in this part is that (a) the crane can swivel sweetly and (b) there is no slobber in the joint so that the crane rocks. If you have used wood I suggest a large diameter washer made of say ten-thou shim-brass and a spot of grease will help.

I see I have forgotten to mention the hook. You can use the meccano type if you like as it's quite strong, but you do need a fair weight on it so that the cord stays taut when reeling in with no load. I suggest a piece of $\frac{3}{8}$ in. brass, drilled through, and about ½ in. long.

General

The outfit needs completing with a little funnel for filling the boiler, a spanner to fit the plugs and the lubricator, a small bottle of oil and, I suggest , a tin which pours properly to keep the spirit in. This stuff is now sold in very dangerous plastic bottles, which not only disintegrate if they get hot, but also tend to squirt out the contents if squeezed *and*, moreover, don't pour. (The reason for forbidding the use of glass containers is *safety*, believe it or not!) You should also write out a proper specification and instruction sheet, as would the makers of a full-size crane.

You may be tempted to arrange the crane with a sheave on the hook, so giving twice the lift. This is up to you, but if you do you may find first that the thing twists (you will need a swivel hook to avoid this) and it halves the available hoist. There is no reason why you shouldn't reel on two or even three layers of cord. The thread on the drum will reel the first layer quite smoothly, and the second and third will follow automatically. When the first layer is knobbly the others follow suit.

Many such pot boilers have an asbestos liner to the firebox; I don't advise this for children's use; not a great risk, but I think parents would prefer that it wasn't there.

There it is, then. I think you'll find you need about a week of nights to make it, but it will give many years of pleasure. Finally, I must thank Messrs. Meccano Ltd., who very kindly provided me with works drawings of their whole range of gears. If your tolerances are as close as theirs the job will work all right.

Introduction to the model steam locomotive

Laurie Lawrence continues his article, explaining the whys and wherefores of model steam locomotives.

The Engine — Crank Setting

I may be taxing your memory a bit, but a while back I mentioned about how, in a two-cylinder locomotive one side of the engine was erected at 90° to the other, i.e. the cranks on one side are at 90° to the other side, and that the cylinders are double-acting and this means there will be 4 power strokes or impulses (pushes on the pistons) per revolution) of the driving wheels. Well, the reason for this is that, through all the gear levers, motion and so on I have been describing, for starting a locomotive at least one cylinder at one end will receive steam and the engine will begin to turn and the locomotive move. The other bits of the engine follow and do their duty in turn and the cycle of events continues. If all the cylinders were arranged on the same crank setting and acted at the same time, it would not only be very unbalanced mechanically and shake like the clappers, it would also be very unlikely to start without assistance. This is the sort of thing which happened in the very early days of steam when men had to shift engines around with pinch bars to get them into position to start; it rapidly led to improvements in design!

In a three-cylinder engine, the cranks are set at a nominal 120° to each other which gives 6 power impulses per revolution of the driving wheels; in a four-cylinder locomotive they are usually set so that one pair of cylinders act together and the other pair act at 90° to them. There are other arangements not appropriate to describe in this sort of article.

The Engine — Exhaust and Blast Pipe

Earlier I mentioned about the steam doing its work in the cylinder and how the valve gear controls the manner in which this is done. Well, having done its work in the cylinder, the steam escapes to atmosphere (out to the open air) and, in so doing, performs another essential function. Connected to the exhaust ports in the cylinders are exhaust pipes or ways and these are directly, that is by the most direct path possible, connected to something called a *blast pipe* **86, 87,** located in the smoke box. This pipe is open at the top and its axis points vertically up the centre line (axis) of the chimney. If the centres of the blast pipe and chimney are not in line, then the exhaust may not function properly. What happens is that the exhaust steam, which has velocity, i.e. it is moving fairly fast, pushes against the gases in the smoke box and ejects them through the chimney. This action causes pressure in the smoke box to be lowered a little below atmospheric pressure and, because nature won't stand for that (the old saying about nature abhors a vacuum), burnt gas is drawn through the boiler tubes from the firebox into the smoke box. This process goes on all the time the engine is working and a similar action takes place in the firebox where air is drawn through the ashpan and up through the burning coal and the process of combustion continues. Of course, you have to put coal on the fire at regular intervals to keep it burning properly.

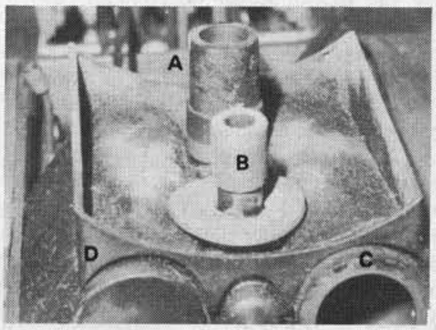
The blast pipe usually has a fitting on it called a *blast cap* or *blast nozzle* and this has a hole in it, bored concentrically with but a bit smaller than the inside diameter of the blast pipe. The function of the blast nozzle is to properly shape the emerging jet of steam and give it the right velocity to do its job effectively. A lot of midnight oil has been burned by locomotive engineers and their model counterparts on the subject of correct blast pipe proportions and it was not until late in the history of steam locomotive development that this subject was fully investigated in full size and correct proportions worked out for British Rail locomotives, including a lot they inherited by nationalisation. In model practice, the beginner is advised to stick to the drawing until he/she has learned enough to experiment and "tune up" a locomotive by any necessary adjustments to the blast pipe and nozzle.

The Engine — Blower

Unlike the domestic coal fire, the steam locomotive has no natural draught passing through the fire and this is the reason why the exhaust steam is turned up the chimney on its way out. You may well ask, "what keeps the fire alight when the engine is not going and no exhaust goes up the chimney? Locomotive engineers produced a simple answer to this; there is a fitting called a *blower* or *jet*, which is under the driver/fireman's control and which he can turn on when needed. In model practice, the blower is often combined with the blast nozzle and it is sometimes only a turned hollow ring, generally of brass, into which a few holes are drilled and jets inserted, **88, 89.** On very small models, the blower may only be a single jet silver soldered on to a steam pipe. The fitting is connected to a small bore steam pipe leading to a steam valve in the cab. Steam from the boiler passes through the valve, through the pipe and emerges through the jets in the blower and thence through the chimney causing the required draught while the locomotive is standing. Careful adjustment of the steam valve and the rate at which steam passes through means that the fire can be kept "ticking over" without dying on you (a crime in model locomotive practice!). Wider opening of the steam valve enables a low fire to be quickly built up and brightened. The beginner should note that the use of the blower whilst running is no substitute for indifferent performance of the blast pipe.

The Engine — Bogies and Trucks

Well, we've nearly got through the engine and, if it was a fixed wheelbase locomotive, i.e. an 0-4-0 or 0-6-0, I could stop the description here and go on to sundry auxiliary matters. But



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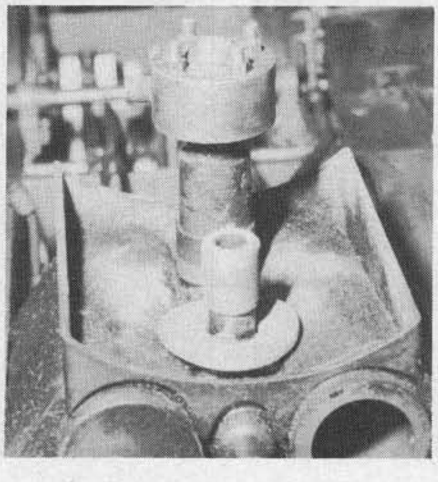
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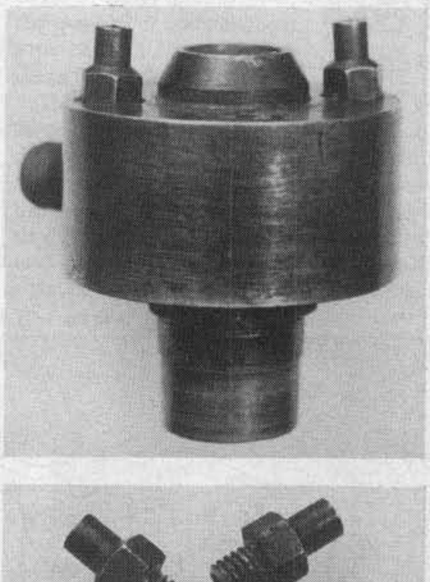
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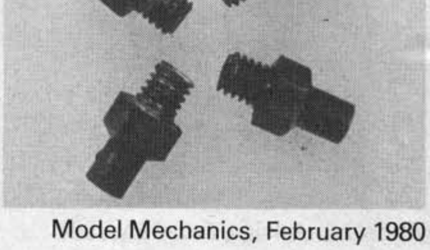
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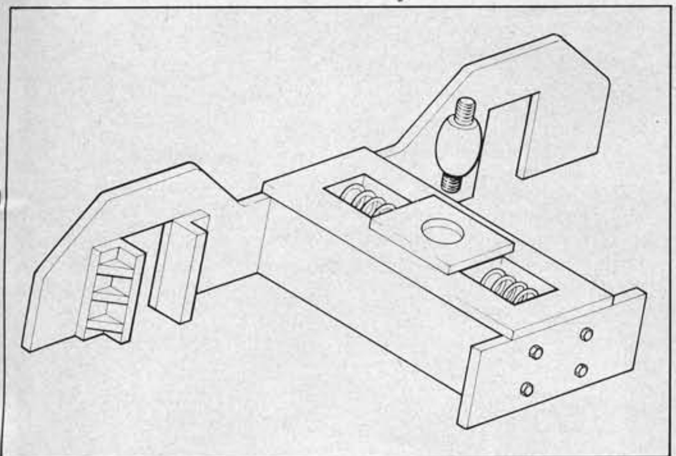
86 *Inside cylinder engine*
A *Exhaust (Blast) pipe*
B *Connection for main steam pipe*
C *Piston valve steam chest (cover removed)*
D *Smokebox saddle*

87 *Combined Blast nozzle and blower fitted into blast pipe*

88 *combined Blast nozzle and blower ring (2 jets removed for clarity)*

89 *4 small jets, screwed into blower ring*



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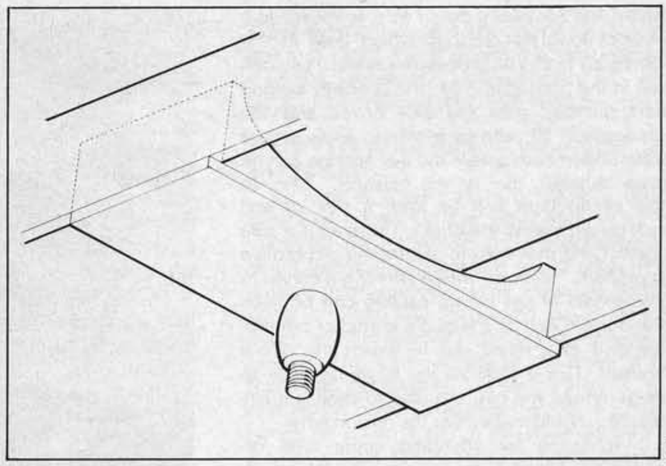
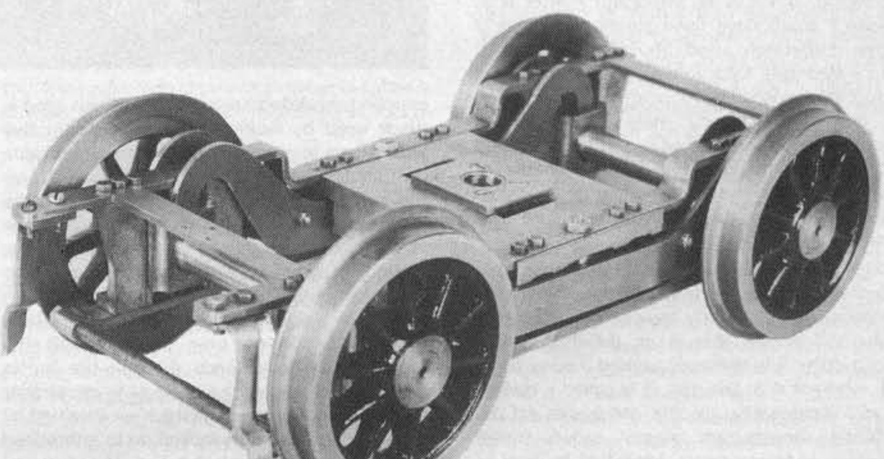


90A

a great many locomotives have bogies and or trucks, so we need a short description of these important items. I briefly touched on the bogie early in this series and this is another item where variety abounds. Construction is often similar to that of the engine main frames, but on a much smaller scale and they can be plate named or bar framed. Plate frames have attached to them the usual horns or horn-cheeks where they don't span the top of the axle box slot. My sketch **90, 90A** shows a simple layout of a bogie in which the wheels would be outside the plate frames; alternatives to this would have the horns outside the frames; in some arrangements the frames are outside the wheels. There is even on famous class of locomotives in which the rear wheels are outside the frames and these are then cranked to come outside the leading wheels! Another variety of bogie construction uses what are called *bar* frames, which, as the name suggests, are made up from steel bars assembled as a framework to contain horns, which are called *pedestals* in the bar frame type, the axle boxes and other parts. The frames of both types are held together by a stout casting called a *bogie centre casting* and also stretchers or bars across the frames at strategic points.

As with the engine axle boxes, those in the bogie also have springing and this, as you might now expect, can be of a variety of types. There is the simple pair of coil springs per axle box, each spring arranged a little to one side of the box in spring *hangers* and quite often bearing on to the ends of a nest of leaf springs on which the box presses. This makes for a fairly lively and responsive arrangement although in the more simple locomotive the nest of leaf springs is sometimes simulated by a small casting. (This detail can be seen when we come to the description of the tender). Leaf springs are made from spring steel strip, cut to length, cambered, i.e. slightly curved, and assembled in carefully graded lengths into a *buckle* which holds them firmly together. Under load, pressure by the axle box causes them to flex and absorb shocks and, most important, keep the wheels in contact with the rail. In model locomotives, full leaf springs are usually too stiff for our purpose and the more exacting model engineer removes a lot of the inside of most of the leaves to make them more suitable for the loads borne but still retain the scale appearance. There are other dodges used.

Instead of simple coil springing, a bogie may have what is called *equalised* springs; this is chiefly found in bar framed bogies but sometimes found in the plate framed type. Briefly, two tops of two axle boxes on one side of the bogie bear on to a specially-shaped box or bars which span both axle boxes; contained



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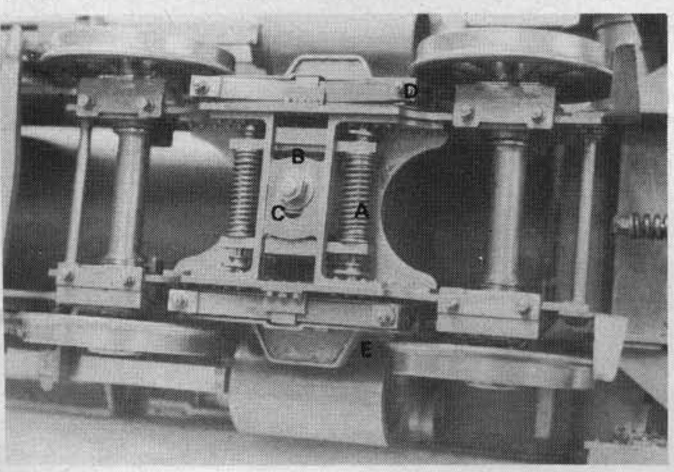
90 *Cut away view of simple Bogie construction*

90A *Cut away view, underside of simple Bogie pin stretcher*

91 *Torquay Manor Bogie showing specially shaped bars humped over the axle boxes*

92 *Underside view of a Bogie*
A *Side control springs*
B *Bogie centre casting with slot for sideways movement*
C *Bogie Pin*
D *Nest of Leaf springs*
E *Bogie bearing pad*

93 *The reason why a Bogie needs sideplay (exaggerated)*



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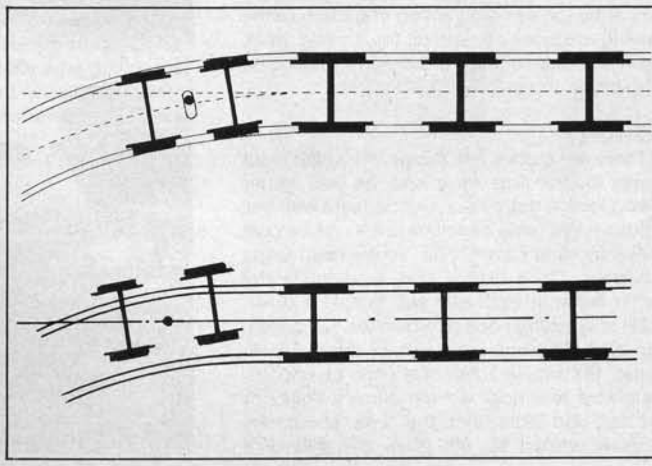


93

within the *equalising beam* as it is called, is a nest of long leaf springs which bear at the centre on to the bogie centre casting. You can see in the photograph **91,** the specially shaped bars humped over the axle boxes and the photograph **92,** shows a similar arrangement from underneath where the leaf springs can be seen outside the centre casting. Also in this photograph will be seen a pair of coil springs set across the bogie. These are for *side control* and they help to ensure the locomotive is properly "steered" when entering a curve. In the middle of the centre casting can be seen the bottom end of the bogie stretcher pin and the end of a small slot in which the pin is housed. This is to allow the bogie not only to pivot around the pin, but also to slide laterally and **93,** should make clear the reason why.

I apologise for spending some time on *springing,* but it is an important matter and, whilst I could have used simple examples, I have deliberately used photographs here of more elaborate locomotives to emphasise the importance placed by locomotive engineers on a basic, but utterly essential aspect of locomotive design — that is, get the springing right. Our little locomotives are capable of quite high speeds and of hauling considerable loads, hence the necessity to make sure they ride the track properly.

Now to another variety of assembly for carrying wheels called *trucks.* In British practice, a truck usually has one pair of wheels only and where this is at the front of a locomotive, it is generally termed a *pony truck* **94**; where it is at the rear, it is called a *trailing truck.* Incidentally, on the other side of the Atlantic, bogies are simply called trucks whether at front or rear, identified by *lead* or *trailing* depending on which end of the locomotive the truck is. There have been very few locomotives in this country with a bogie at the rear, **95, 96,** as in the 4-6-4 *Baltic* tanks and we simply say leading bogie and trailing bogie in such cases. However, back to trucks. In its simplest form a truck is rather like the front half of a bogie complete with axle boxes and springing, but with the framing extended to the rear in a sort of 'A' shape. Near the apex of the 'A' will be provision to receive a stout pin from the stretcher across the main frames of the engine. The truck is free to pivot about this pin, but as you may expect, there is some degree of side control springing incorporated.

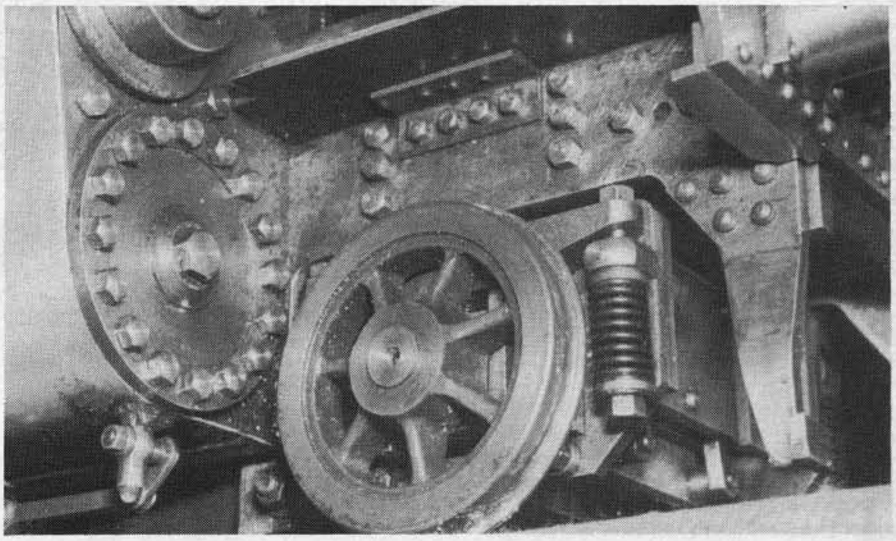
At the rear of the engine a single axle truck is of similar 'A' frame shape but the arms of the 'A' are spread considerably to leave a very large space between them; this is because such trucks are usually fitted to wide fire-box locomotives and space has to be made for the ashpan. There are lots of variations on this theme, but the above is the basic sort of layout. Over here, side control is usually taken care of by the damping action of friction of the bearing surfaces of part of the trailing truck against similar surfaces attached to the engine framing.

Drawgear

There are quite a few things left which most model locomotives have and we had better have a look at these next. Our pleasure with our models is not really complete unless we can get on behind and have a ride, so we need some *drawgear*. On a simple tank locomotive the buffer beam at each end will include a *draw-hook* or *coupling* hook to which we can couple our train. **97,** shows the sort of thing usually found; the simple 3 link chain can be used to couple up to a hook on the driver's trolley or flat car and note that the links should be properly welded **98, 99,** show the links of a coupling modelled on full size and this type is *never* used by responsible model locomotive enthusiasts to couple up to the train, it is quite unsuitable. Generally a driver's trolley will have the correctly made strong drawgear and the chain on this is attached to the coupling hook of the locomotive. *Never* be tempted to use a wound up bit of wire, piece of string or any makeshift coupling. The coupling hook has a square or rectangular section shank which prevents it turning over (and slipping the chain!) and this extends through the buffer beam The shank is long enough to accommodate a short, stout spring which is contained by a washer and two nuts locked on to a threaded portion of the shank beyond the squared section. Some locomotive builders like to put a split pin through one of the nuts and the shank to prevent any possibility at all of the nuts working loose — a runaway locomotive is not a desirable thing to have on a track. There are other methods of preventing the draw-hook from parting company with the engine and other types of drawgear; the above is of a type commonly used.

Fuel and Firing

One important aspect of operating any locomotive is that of "feeding the brute"! It needs coal and water to keep going. A locomotive's capacity to do work (or if you like, its power) depends on the rate coal is fed to the grate and the upper limit of this capacity to do work is the maximum rate at which the *grate will actually burn coal* and this is called the *grate limit.* There is another limiting factor which is called the *front end limit* and this, rather briefly, is the effectiveness of the draughting arrangements (you'll remember the exhaust steam passing through the blast pipe and chimney causes the draught). Modern research has ensured that, in full size anyway, the draught is sufficient to cause enough air to be drawn through the grate and fire to burn as much coal as can be consumed by it. So the front end limit is no longer a limiting factor, only the grate limit matters. Purists — and realists — will tell you this is not always the case and I agree, but for their benefit and yours, one has to assume that there is sufficient *adhesive weight* (which I mentioned



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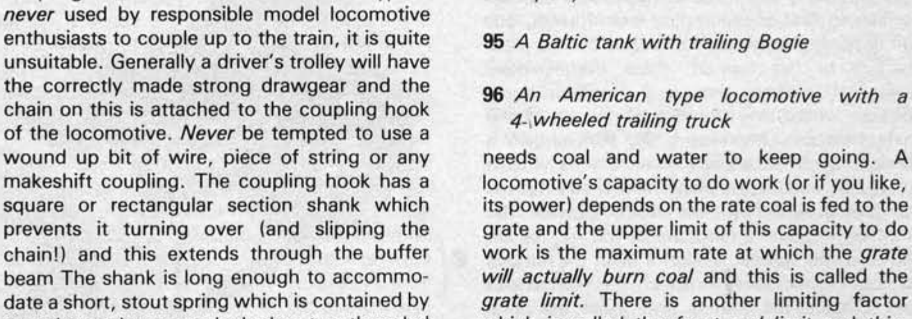

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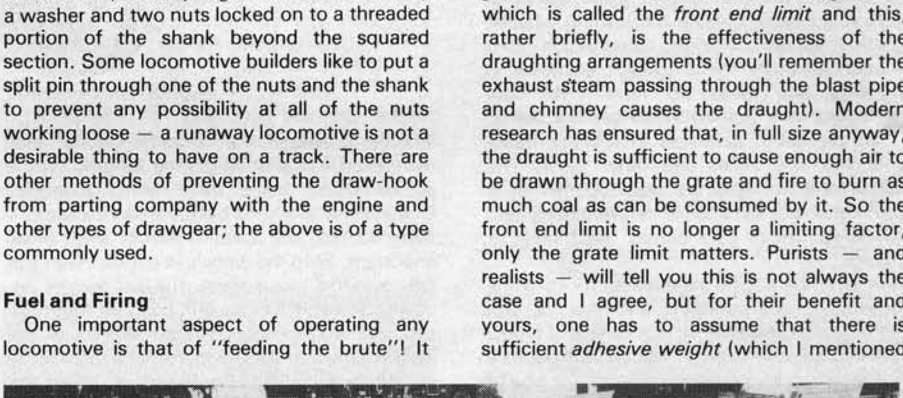

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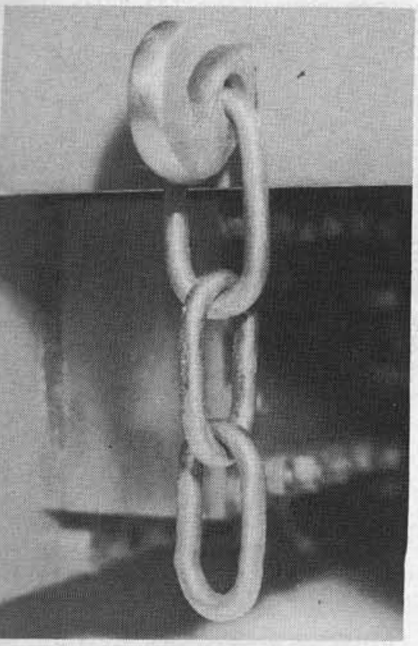
94 *A pony truck*

95 *A Baltic tank with trailing Bogie*

96 *An American type locomotive with a 4-wheeled trailing truck*



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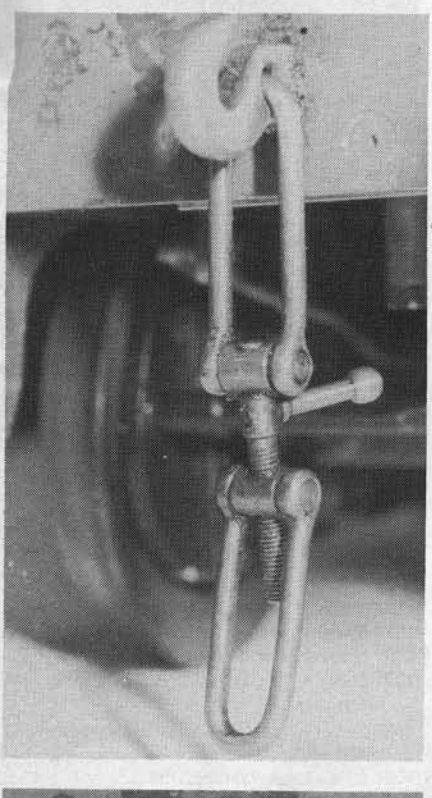

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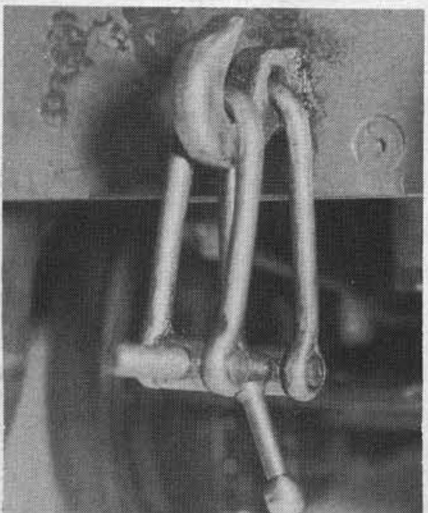

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in the section about cylinders and motion) to enable the full power to be delivered effectively at the wheel rim on the rail without the wheels slipping.

However, back to coal; the best type of coal for our little locomotives is *steam coal* and this comes from various pits in this country. Ordinary house coal is not suitable for the high combustion rates of the locomotive firebox. Very highly regarded is *Welsh steam coal*, a soft friable coal which can be broken quite easily into small pieces suitable for our small fires. Unfortunately, breaking this coal produces a lot of small grains and dust which falls through the firebars or gets blown out of the chimney straight into your eyes, a circumstance which many drivers mitigate by wearing protective eyeshields. Another fuel used is *Anthracite* or semi-Anthracite which can be obtained already graded in pea or bean size as used for domestic boilers. There is less waste with this fuel but it needs somewhat more draught than steam coal, what is called a sharper draught and not every driver is happy with it.

The implement one uses to put coal on the fire is, of course, a *shovel*. Model engineers make their own miniature shovels and a tremendous variety can be found from massacred old teaspoons to accurately scaled full-size ones. It may sound odd to talk about the efficient shovelling of coal on to a fire but all the time the firehole door is open, excessive cold air is being drawn into the firebox and proper combustion of the coal is hindered. A little air through the firehole is necessary, *top air* or is called, so the normal position of a firehole door is shut and top air goes through the small holes in the door specially made for the purpose or a sliding door is just cracked open. Shovelling coal on to the right places so that there is an evenly burning firebed is done skilfully and quickly and the shovel withdrawn and the door closed. My photograph shows a "scale" Great Northern shovel and one which is of a shape very much in favour with "model" firemen, note the rounded off back so that the shovel is easy to withdraw from the firehole without snagging, **100.**

The only other fire tool in use is a *pricker* otherwise known as a slice, rake, dart or by the mundane name of poker. It is used *with discretion* to clean the fire of dead ash and clinker. *Clinker* is an enemy of fires and is the incombustible residue ash which has fused on the fire bars of the grate and interferes with the free flow of air to the fire. Some coals have a habit of forming clinker especially when being worked very hard or when the draughting is not right. The pricker is only a length of steel rod, often with the business end flattened and some form of handle provided to hold it with. Too much and too frequent stirring of the fire does more harm than good by disturbing the formation of the fire unnecessarily. Incidentally, grates are usually arranged so that by pulling out a pin the fire can be dumped at the end of a steaming session and cleaning

97 *Coupling hook with simple 3 link welded chain*

98 *An overscale coupling modelled on full size*

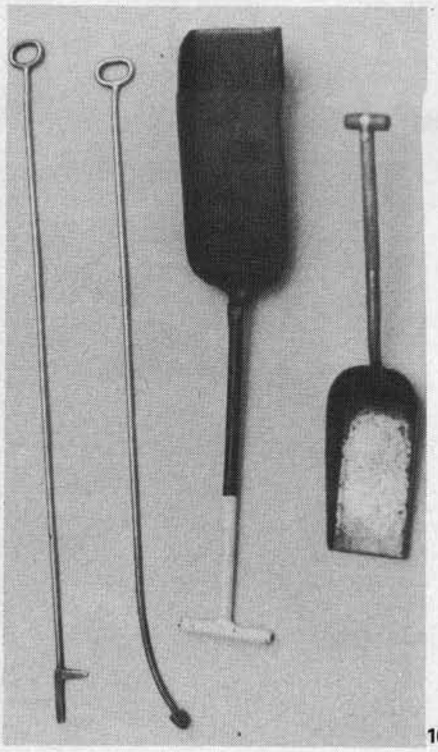
99 *The unused coupling on front buffer beam, hooked up for running*

100 *Firing tools*
A *Pricker*
B *Pricker*
C *Popular type of shovel*
D *Scale L.N.E.R. shovel*

down is simplified, it is also used to dump the fire in a hurry if this unwelcome step should ever be necessary; emergencies do very occasionally happen, *101, 102, 103.*

Water Feed to the boiler — Injectors and Pumps

No one of course lights a fire in a boiler empty of water! So the initial lighting up is done with the water level in the boiler showing about half-way up the water gauge glass, that is, at its normal working level. However, as the water is turned into steam and drawn off the boiler, some means of replenishing the level is needed. The water supply to the boiler is by four basic methods (a) live steam injector, (b) axle driven pump, crosshead pump, (c) hand pump, (d) steam pump. A *live steam injector* is a small gadget **104,** in which a jet of steam is encouraged to send a flow of water into the boiler. In the Model Engineer in 1975 it took me abut 30 pages to write on the subject of model locomotive injectors and I don't intend to repeat that performance here, but those articles are there for anyone who wishes to study the subject more deeply and perhaps have a shot at making their own injectors. I called these small gadgets *live steam* because the steam is taken direct from the boiler and the term is used to distinguish that from exhaust steam which has done its work in the cylinders. There are exhaust steam injectors in full size, but I have yet to see a satisfactory one on a model. Inside an injector there are a number of tapered tubes known as *cones* set in line and whose function is to convert the energies present in the steam and water into a different sort of energy, pressure energy, and so force water at a higher pressure than the boiler pressure into the boiler. Yedars ago model locomotive builders counted themselves very fortunate indeed if they got a small injector which worked at all. Nowadays successful injectors are quite common. An injector is usually graded by the amount of water it can feed into the boiler per minute, i.e. 25 ounces (1¼ pints) per minute capacity. An injector has a distinct advantage of being able to put water into the boiler while the train is standing as well as when it is running.



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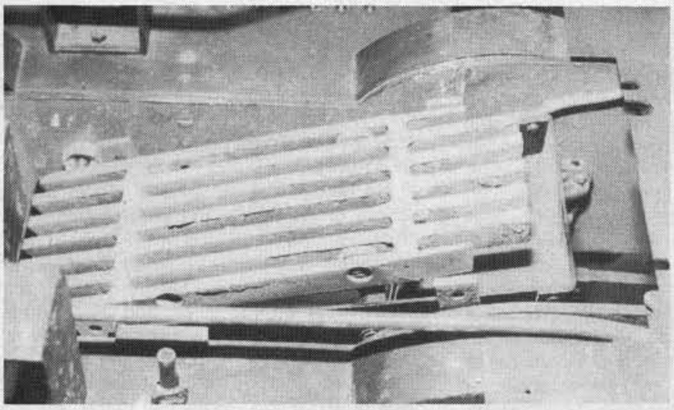

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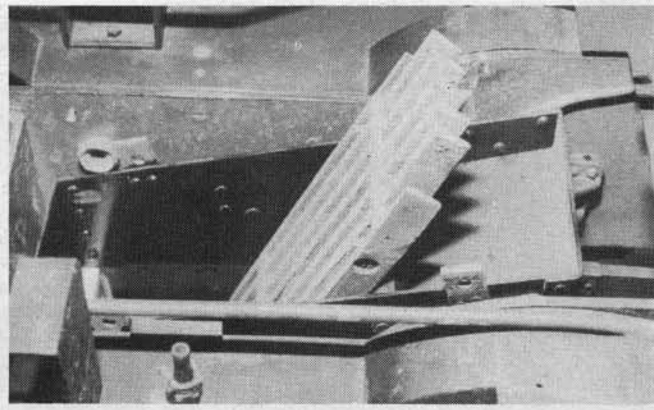

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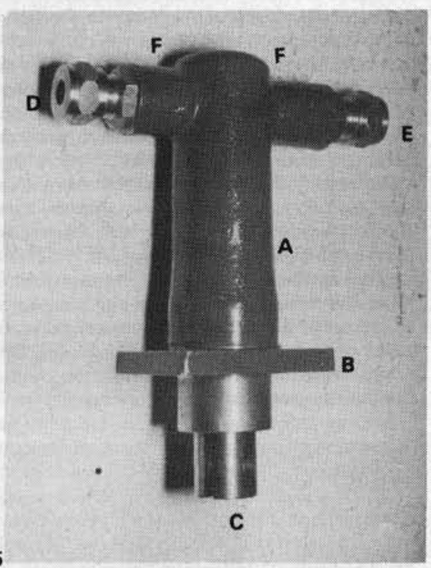
By far the most common means of boiler feed is by an *axle driven pump* **105, 106**; you'll remember our old friend the eccentric and one (or more) of these is mounted on a driving or coupled axle with an eccentric strap or sheave round it. Firmly attached to the strap is a *pump eccentric rod* which is connected to a *pump ram*, a sort of long parallel piston, by means of a stout pin crosswise through the end of the ram and a suitable close tolerance hole in the pump rod so that it is free to turn about the pin. When the engine is moving, the eccentric is turned by the axle and this causes the pump rod to alternately push and pull the pump ram in the *pump body*. Generally the pump body is a casting firmly attached to a pump bracket, stay or stretcher set in the engine frames and the ram is a nice close sliding fit in a deep machined hole in the body. The clearance round the ram has to be very small, about half of one-thousandth of an inch is common, so that leakage of water past the ram is minimal and a gland, similar to those fitted on piston rods, seals the end of the pump ram near the pin. In the body, usually at the opposite end to the eccentric, are passages connecting with pipes carrying the incoming water supply and the delivery (boiler) side. Each of these passages contains something called a non-return valve which is usually just a rustless steel ball on a machined seating—which is a little smaller than the diameter of the ball. In the ball chamber in the passage way there is space round the ball to allow water to pass by and also the way is partially plugged to limit the lift of the ball.

Non-return valves are also known as *check valves* and, more commonly, *clacks*; I will be mentioning them again soon.

The pump works like this, on the *out stroke* (suction stroke) of the pump ram, water is sucked into the pump past the ball, which lifts, in the non-return valve on the supply side and the ball on the delivery side is sucked down on to its seat preventing any water flowing back from the delivery down into the pump. If this did not happen, a small quantity of water would merely be pushed to and fro without any going into the boiler and that isn't the idea! On the *in stroke* (forcing stroke) of the pump ram, the suction side non-return valve closes back on to the ball seat, the delivery ball lifts under pressure from the water and water is forced past the delivery side ball into the boiler. This



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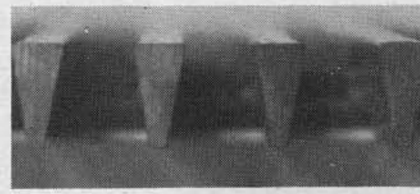

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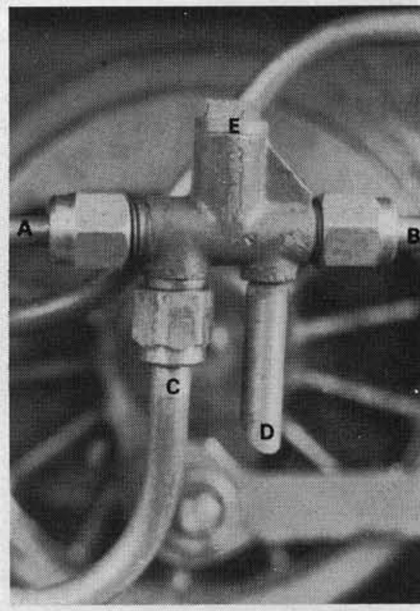

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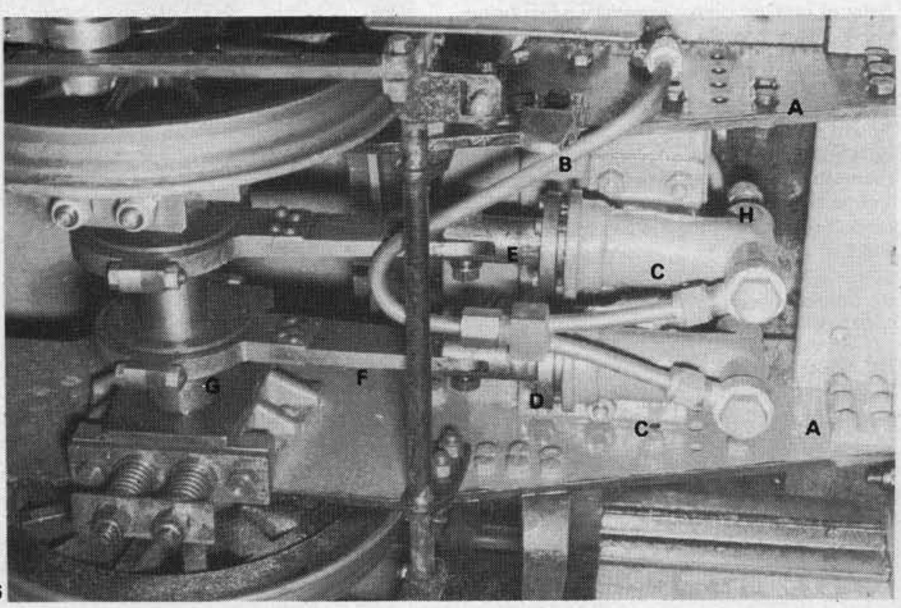

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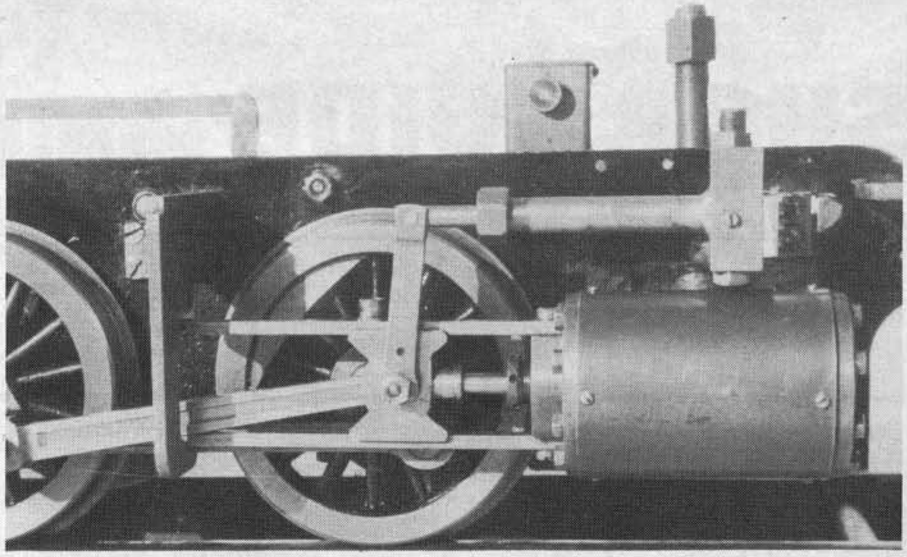
101 *Narrow firebox grate in frames (Boiler removed for clarity)*
102 *Dump pin removed, grate tips to dump fire*
103 *Correct taper section of fire boxes permits ash to fall through*
104 *Live steam injector*
A *Steam pipe*
B *Delivery pipe*
C *Water supply pipe*
D *Overflow*
E *Injector casing*
105 *Typical axle driven boiler feed pump*
A *Body casting*
B *Flange for fixing to pump bracket of stay*
C *Pump Ram*
D *Water inlet*
E *Water delivery*
F *Non-return valves contained within*
106 *Underside view of twin axle driven boiler feed pumps*
A *Engine frames*
B *Water supply pipe*
C *Pump body*
D *Gland*
E *Pump Ram*
F *Pump Rod*
G *Eccentric*
H *Water Delivery*

cycle continues all the time the engine is in motion.

A *crosshead pump* is very similar to an axle driven pump except that the pump ram is connected via a pump rod to the crosshead, **107**, the whole arrangement being carefully erected in line. Because the pump ram will have the same length of stroke as the piston, the pump ram is usually a lot smaller in diameter than that of an axle driven pump. Also, crosshead pumps usually have a large space round the pump ram, often as much again as the ram, although they work on the same principle as the axle driven type. The same type of non-return valves are fitted.

Model locomotive designers estimate the size of pump or pumps necessary to feed the boiler at its maximum steaming rate, but the demand for steam by the engine will vary with the amount of work it does and you will appreciate that an engine working hard at a given speed will need a lot of steam and thus a lot of water, whereas at the same speed but hauling a bag of feathers it will use less steam. But the axle or crosshead pump is delivering water at the same rate because it is making the same number of strokes as revolutions of the drivers and the boiler will overfill unless some means is provided of regulating the water being delivered. This is done by means of a *by-pass valve* set in the delivery side of the pump and its function is to permit anywhere from all to none of the delivery to be diverted from the boiler feed pipe back to the water tank, **108, 109.**

In essence the by-pass valve is the same as any other stop valve, like the steam stop valves for the various auxiliaries. The delivery water does not flow into the by-pass and then on into the boiler; the valve is merely fitted into a Tee into the delivery pipe and, when the valve is open, water finds less resistance through the by-pass than going into the boiler where it has to overcome boiler pressure before entering, so it takes the easy path of less resistance back into the tank or tender via a pipe provided for that purpose. If the resistance through the by-pass is increased by partially closing the valve, some of the water will go into the boiler and some back into the tank. The valve spindle of the by-pass is screwed into the body so that it can be finely adjusted to regulate the water flow commensurate with the demand for steam



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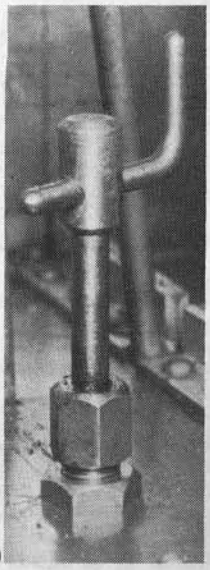

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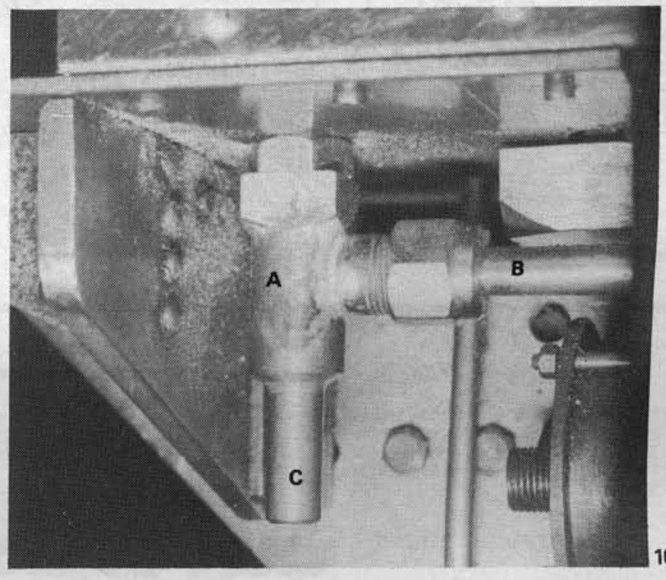

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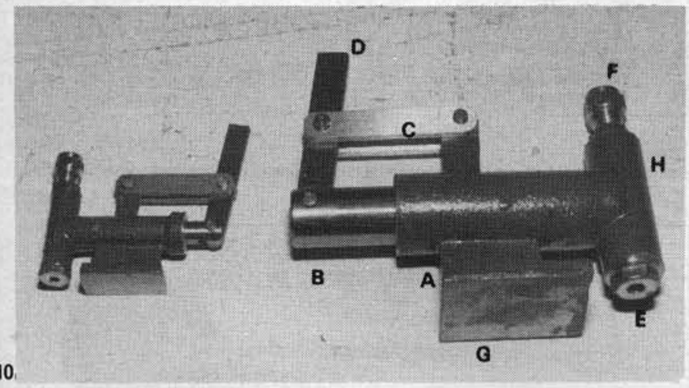
By-pass valves are very nearly always only fitted to mechanical pumps like axle pumps.

Hand pumps, as you may guess, are operated by hand, **110, 111, 112,** they are usually placed inside and fastened to the plates of side tanks or in the tender. The body is very similar in construction to that of an axle pump but instead of the pump ram being driven from an eccentric via a pump rod, the outer end of the ram connects to a quite simple system of levers, sometimes called a bridle or yoke, and a removable handle is put into place on one of the levers. When this is waggled to and fro, the pump ram does likewise and water is driven into the boiler via the usual non-return valve and delivery pipe.



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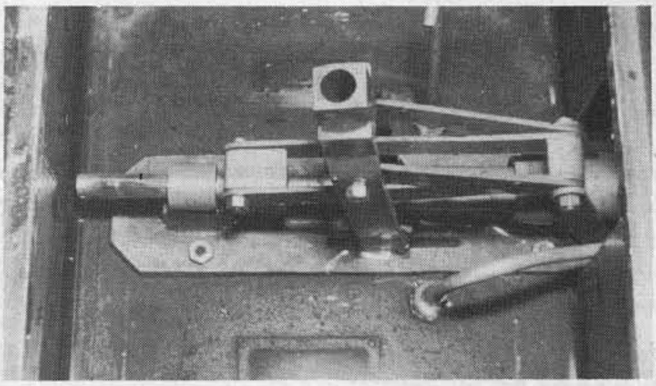

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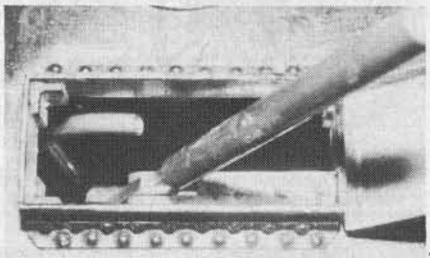

112

107 *Boiler feed pump driven from crosshead*
108 *By pass valve under footplate*
A *Valve body (under footplate)*
B *Pipe from axle pump*
C *Hose connection back to tender*
109 *The handle of the by pass valve*
110 *Large and small hand pumps (as supplied by Kennions Ltd.)*
A *Body*
B *Pump Ram*
C *Yoke or Bridle*
D *Handle (extension fits on here)*
E *Inlet for water*
F *Delivery*
G *flange for fixing to tank*
H *Non return valve contained within this part*
111 *Hand pump mounted in a tender and immersed in water supply*
112 *Handle (detachable) pokes through access hole in tender/tank top*

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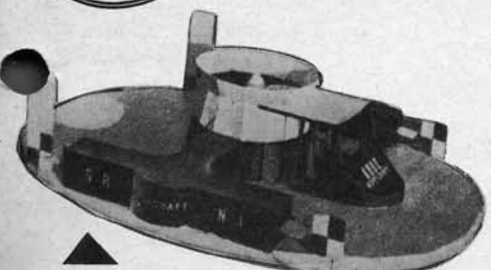

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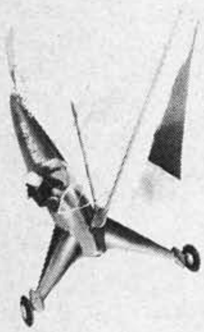

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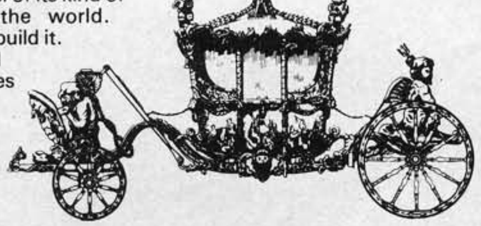

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